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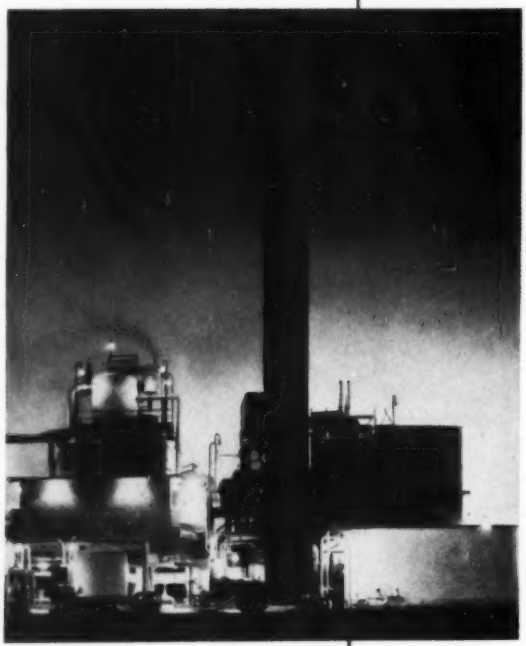
THE ECONOMICS OF STEAM ENGINEERING

chemical progress

STEMS FROM

STEAM



Steam plays a major role in the fast-growing chemical process industries, which consume more than a third of all energy, in the form of fuels and electricity, that is used by all of America's manufacturers. A most economical medium for harnessing usable energy, steam challenges the ingenuity of the engineering profession to find ways to burn new waste products as fast as new processes create them. Already, steam is used to derive useful heat and energy from butane, asphalt, refinery residues, sewer sludge, paper mill liquors, bagasse, grain and nut hulls, cotton lint, and wood refuse.

By 1960, the annual production of the chemical process industries will hit $61 billion. No wonder steam engineering, an important common denominator of this fabulous industry, offers challenging careers to physicists, mechanical engineers, metallurgists, civil engineers, chemists and a host of others who are making history with their slide rules.

The Babcock & Wilcox Company, Boiler Division
161 East 42nd Street, New York 17, N. Y.

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Theories proved or exploded here

• Before you place a new design on the market, it is important that you know how it will work under operating conditions.

Where the design involves the use of anti-friction bearings, New Departure's new, ultra modern testing laboratory can determine *in advance* what performance you can expect "in the field".

Furthermore, as the study progresses, New Departure engineers may find it possible to improve the performance or the assurance of success by applying their ingenuity and their fund of knowledge and over forty years experience to the subject at hand.

May we work with you on your anti-friction problems?

Nothing Rolls Like a Ball. ™

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • Division of GENERAL MOTORS CORPORATION • BRISTOL, CONNECTICUT • BRANCHES IN ALL PRINCIPAL CITIES

MECHANICAL ENGINEERING, June, 1952, Vol 74, No. 6. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢, to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

For Editorial Contents See Page 443

How would YOU solve these two problems?

POSITIVE BRAKE-ACTION, so essential to public safety, is aided by use of the Permafuse Corporation's special brake-bonding oven. Installed in progressive service stations, the Permafuse oven fuses the adhesive-coated brake lining to the brake shoe evenly and permanently. A low-cost, rugged THERMOSWITCH® unit keeps oven temperature constant for proper bonding and keeps service calls to a minimum.

PREVENTION OF SPOILAGE in refrigeration applications is a matter of constant, exact temperature control. In the Jewett Hospital Blood Bank, for example, temperature is maintained at 37°F within plus or minus 2 degrees. Two Fenwal THERMOSWITCH thermostats serve as an alarm device, warning instantly against freezing or refrigeration failure if temperature goes below 32° F or above 48° F.

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SEND FOR THIS CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal, Incorporated, 56 Pleasant Street, Ashland, Mass.

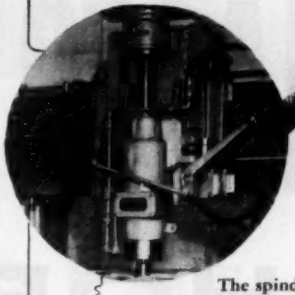
Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE... but only to heat

How "ABUSE CAPACITY" is built into a 12 speed spindle



The spindle of Pratt & Whitney's 40" Vertical Profiler and Miller is designed for 12 operating speed ranges from 260 to 6200 r.p.m. Machine operations may be confined to continuous production at any one speed for extended periods. The diversification of operating conditions represented puts an extremely heavy burden on spindle bearings.

"Abuse capacity" is provided by the aristocrats of all bearings . . . Fafnir Super-Precision ball bearings. Four pairs support the main spindle and drive shaft. Notice how they are arranged in the cross section diagram. This set-up not only assures positive axial and radial rigidity, but also provides for shaft expansion. The bearings run cool under varying conditions of load and speed . . . conserve power . . . need no adjustment . . . and are permanently grease packed.

Whatever your bearing problem, a few minutes spent with a Fafnir representative may help you solve it as successfully. The Fafnir Bearing Company, New Britain, Conn.

Bearings used
Fafnir Super-Precision Ball Bearings made to extremely close tolerances, assuring accuracy and smoothness of operation . . . counterbore construction with shallow shoulder on one side . . . one-piece, composition retainers.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

BUILDING FURNACES?

LOW HEAT CAPACITY is an inherent property of ALFRAX BI aluminum oxide refractory. It's literally made of bubbles — hollow spheres of Al_2O_3, specially bonded together. It has good load strength, is an exceptional insulating material for jobs over 3000F. Also available as a castable cement. Just mix with water and handle like Portland cement.

SHORT ON

here's help

How to keep shortages of certain critical alloys and refractories from delaying furnace construction.

For want of certain scarce heat resisting metals or special duty refractories, many furnaces nowadays get nine-tenths built . . . then wait for the scarce materials. Surprisingly often, this delay could be avoided by substituting our Super Refractories. These materials *are available.* They do have the properties needed. And they'll generally outperform the metals or refractories they replace, *at a lower final cost.*

Consider metals, for example — how do Super Refractories compare? To begin with, they are generally very strong. (The

Use Super Refractories by

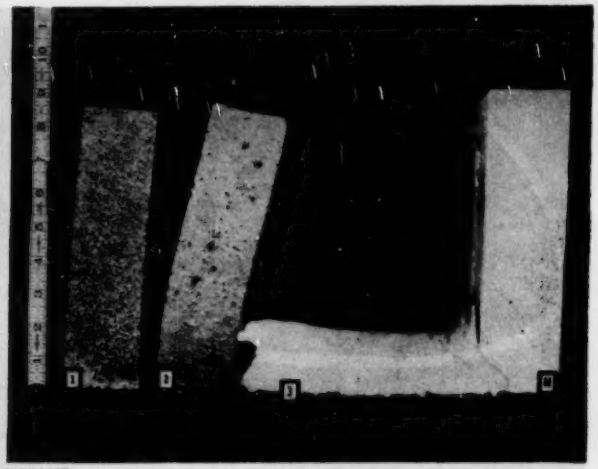
CARBORUNDUM

Trade Mark

Refractories Division — **The Carborundum Company, Perth Amboy, N. J.**

"Carborundum", "Carbofrax", "Multifrax" and "Alfrax" are registered trademarks which indicate manufacture by The Carborundum Co.

ALLOY REPLACEMENT is an important function of our CARBOFRAX silicon carbide refractories. These unusual materials often double for furnace parts made of chrome, nickel or cobalt alloys, such as skid rails, muffles, roller hearths, radiant tubes, brazing fixtures, etc. They not only outlast metals, but can also increase the capacity of your equipment.



MULLITE refractories of certain types are often hard to get. However, the purest of the mullites — MULLFRAX electric furnace mullite — is still available. Made by melting together exact proportions of high purity raw materials, it is an entirely synthetic product. Hence, it is purer and more refractory than mullite obtained from natural sillimanite. Note, in the test above — five hours at 3000F — that the MULLFRAX brick ("M") is the only one of these four commonly used refractories, untouched by the heat.

MATERIALS?

modulus of rupture of one Super Refractory averages 3100 psi at 2460F). Most important, they *retain their strength* at temperatures where metals are unusable. All Super Refractories can be safely used considerably above 2800F, whereas 25-12 chrome-nickel steel loses strength rapidly over 1500F, is unsafe over about 2100F.

Some Super Refractories are also more resistant to abrasion than metals, particularly at furnace temperatures. In fact, they are the *toughest known materials* for large scale use. Super Refractory hearths, skid rails, etc. distinctly outwear their alloy counterparts.

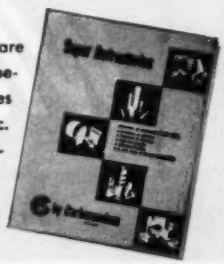
Muffles, hearths, radiant tubes and other indirect-heating furnace parts, which must transfer heat rapidly, are often made of Super Refractories. *One Super Refractory conducts heat almost as rapidly as chrome nickel steels!*

You'll find our Super Refractories, too, where chemical attack is severe. They're used in muriatic acid furnaces, hydrogen cyanide converters — even as spray nozzles for sulfuric acid.

There's another Super Refractory that has good insulating quality, particularly at temperatures over 3000F. This material makes an excellent low-heat-capacity lining, for either facing or backing up purposes.

In fact, for practically any combination of furnace conditions — high heat, heat shock, flame impingement, etc. — there's usually a Super Refractory to fit the job . . . and do it better. So don't wait until scarce materials get scarcer. Check up on Super Refractories now. Remember, it's not the first, but the *last cost* that counts — and an unfinished furnace becomes increasingly costly. Write or call us today.

Practically all Super Refractories are available as cements, bricks, or special shapes moulded to close tolerances — including fitted joints, tubes, etc. Information is available on the principal properties of all major compositions. Just send the coupon for our free booklet.



Dept. P-62
Refractories Div., The Carborundum Co.
Perth Amboy, New Jersey

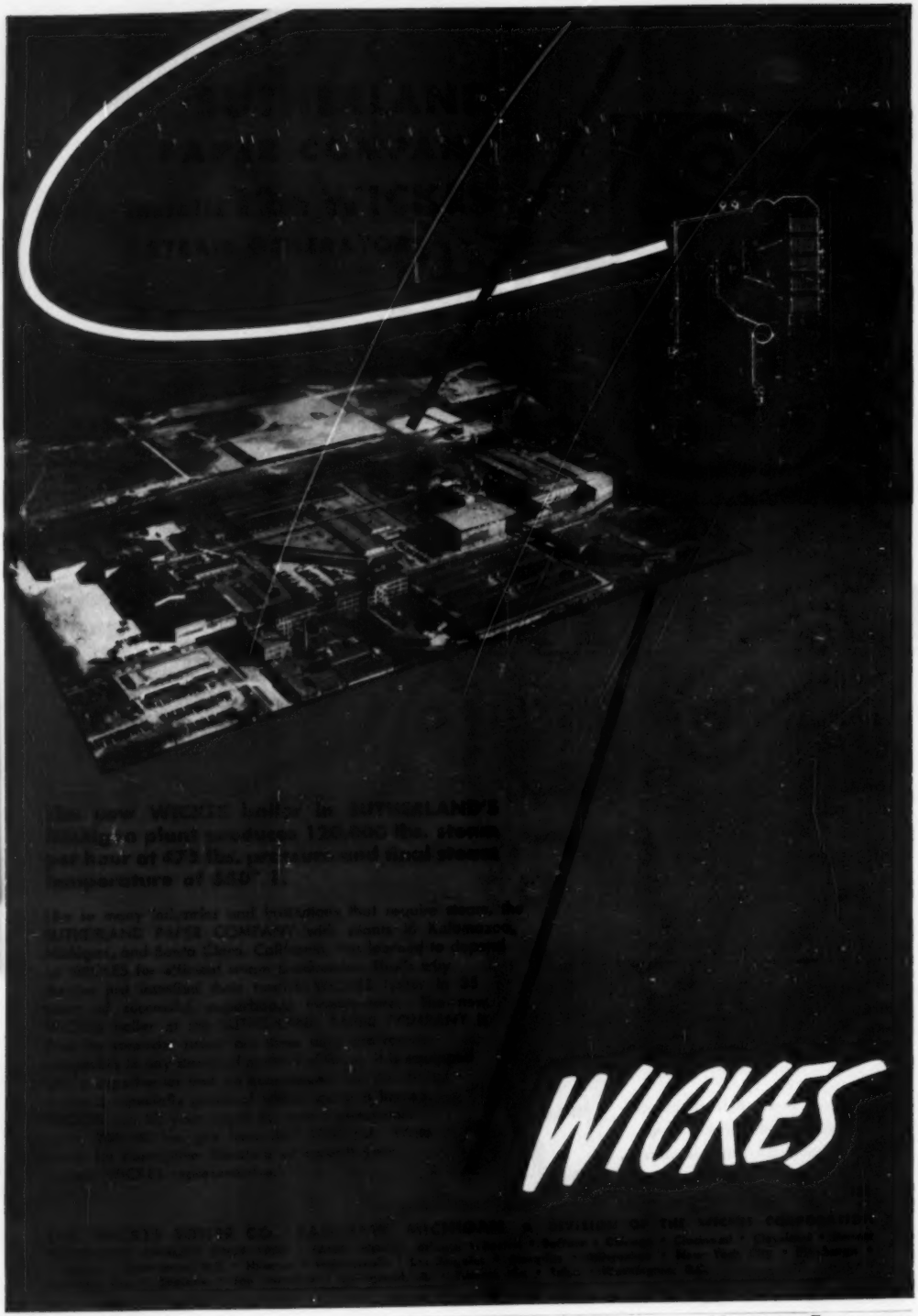
Please send your free booklet on properties of Super Refractories.

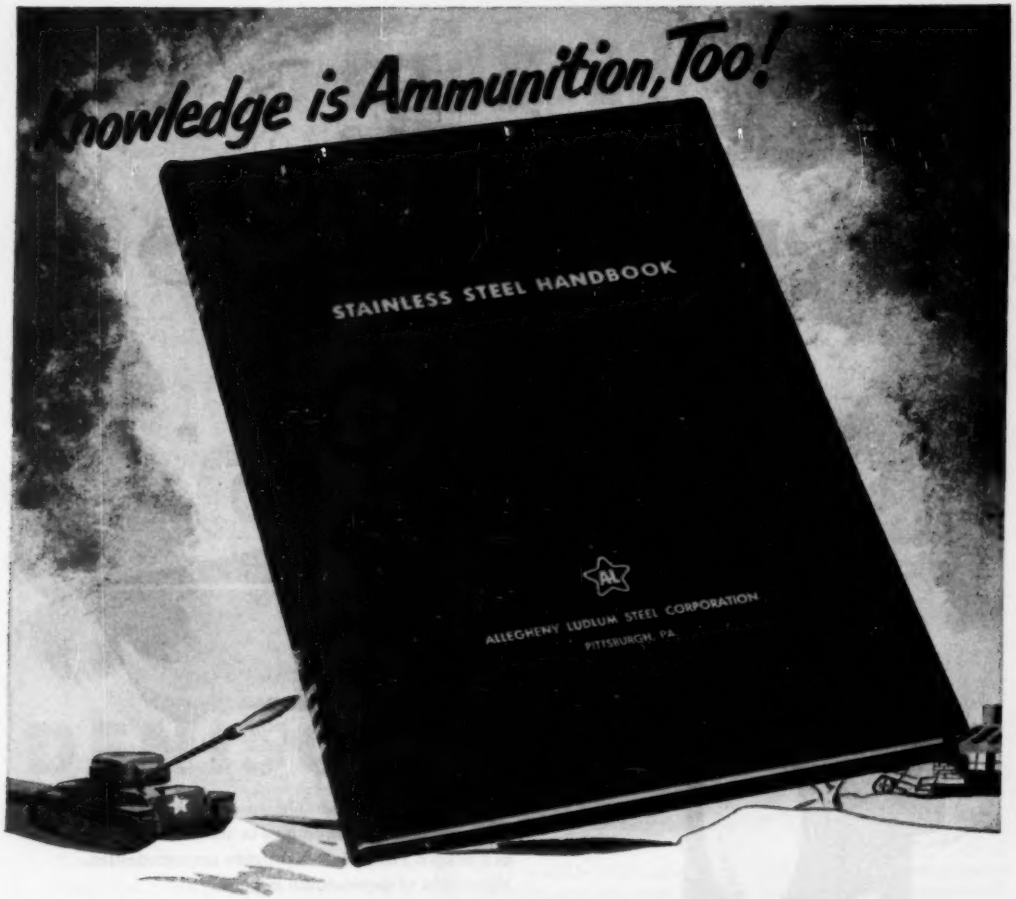
Name_____

Position_____

Company_____

Street_____


WICKES



Here's 124 Pages of Valuable Data on STAINLESS STEEL

Stainless steel is a critical rearmament material. As the nation's mobilization program shifts into higher speed, supplies of this vital alloy are becoming increasingly restricted. If you're using stainless, be sure you make every pound go as far as possible.

Allegheny Ludlum's new 124-page, case-bound Stainless Steel Handbook is ready for distribution now. It will help you to select the right stainless steel and to use it right. Comprehensive listings of analysis, properties and characteristics of each type will guide you in specifying grades that will do your job most efficiently. Clear, concise fabrication data will help you speed production and cut waste.

Your copy of the Stainless Steel Handbook will be sent—*without charge*—upon request. Our only stipulation: please make your request upon your company letterhead. • Write Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.

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Remember this also
America must have more Scrap to make more Steel!
Get in the Scrap Now!

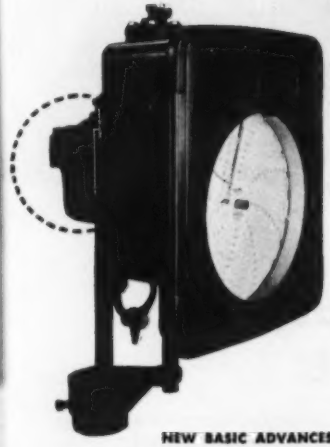
You can make it **BETTER** with
Allegheny Metal

AL
TIME-TESTED STAINLESS STEEL

A meter drive that's miles ahead...

...in sustained accuracy

...in maintenance freedom



NEW BASIC ADVANCES

- **Precision float assembly** with stainless steel ball chain and collet-type clamp insures positive, friction-free transmission of float motion through the segmental drive.
- **Pressure-Seal Bearing** is virtually friction-free, completely leak-proof.
- **Sure-Seal Check Floats** insure perfect seating; submerged in mercury to prevent frosting and fouling.
- **Union-coupled U-bend** eliminates gaskets; always lines up.
- **Calibrated Damping Plug** fully adjustable under pressure.

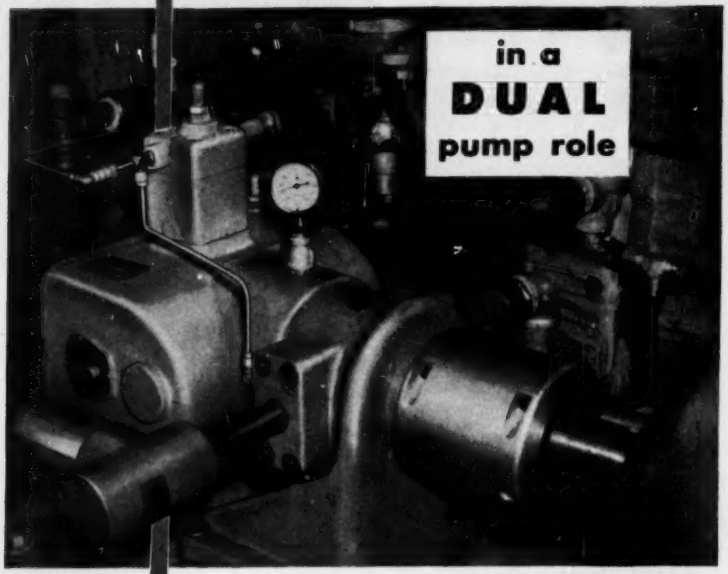
New, outstanding advances in the basic details of Foxboro Flow Meters provide unprecedented standards of dependable accuracy.

For example, Foxboro's exclusive, segmental drive assembly, which eliminates angularity errors altogether, now employs: ❶ stainless steel ball chain that insures perfectly free travel of float . . . ❷ slip-proof collet for positive clamping of segment to the bearing shaft.

Check *all* the advantages of Foxboro Flow Meters, including extra power due to large floats and long travel; float located in high pressure chamber to minimize ambient temperature effects; submerged-in-mercury check floats which prevent mercury losses; unvarying accuracy throughout years of use. Write for Bulletin 460. **The Foxboro Company, 1826 Neponset Ave., Foxboro, Mass., U.S.A.**

FOXBORO REG. U. S. PAT. OFF. ... First in FLOW METERS

Rugged Dependability



DENISON

Wherever *high-pressure holding cycles* are required, Denison Compensator Controlled Pumps offer *proved performance* that provides both high volume-low pressure and low volume-high pressure operation in any combination, for any need up to 5000 psi.

Write today for Bulletin P-4-2, or for data on other pumps and controls for any need.

Compensator-Controlled Pumps

Denison Compensator Controlled Pumps play a dual role that cuts costs in circuits designed for intermittent high-pressure operation.

They provide high-volume oil delivery during low-pressure operating periods, then maintain full pressure with *minimum oil delivery* for the hold-down or work period.

Actuated by the system pressure as it reaches maximum, the compensator control automatically changes the volume by regulating the stroke length of the pump pistons.

Compensator controlled pumps save horsepower during dwell periods. Less space is required than in equivalent two-pump circuits. They eliminate many needs for unloader valves, extra piping and double-end-shaft electric motors. They often permit the use of smaller electric motors. Other advantages include increased circuit efficiency, simplified circuit design, and lower maintenance costs.

Rugged, compact construction and dependable axial piston design combine to assure high volumetric and over-all efficiency with long lasting, low maintenance service. Compare the dual efficiency and economy of Denison compensator controlled pumps with the ordinary two-pump set-up. Available in 10, 20, and 35 gpm capacities, for operating pressures up to 5000 psi, they permit unlimited adjustment of control for varying requirements.

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Cuno MICRO-KLEAN handles a wide range of fluids and flow rates with low pressure drop. It is guaranteed to remove 100% of all solids for which it is rated plus a large percentage down to 1 micron.

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Company.....

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Cartridge renewals are cut at least *in half* when Cuno MICRO-KLEAN replaces any other filter. And throughout its service life, MICRO-KLEAN is *guaranteed* for specific performance.

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Kinds of Fluids

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
Filter fuels, lubricants, process fluids, etc.—MICRO-KLEAN
Clean raw water, recirculating water, etc.—FLO-KLEAN

VARIABLE SPEED REWI

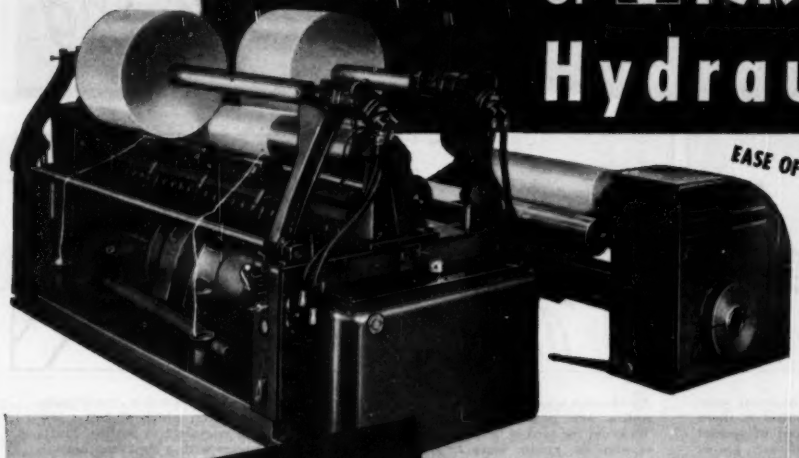
SIMPLICITY OF DE

Another COST-CUTTING APPLICATION OF VICKERS Hydraulics

EASE OF MAINTENANCE

GREATER OUTPUT

COMPACT



New

BAGLEY & SEWALL No. 15 Duplex Slitter-Rewinder

Vickers hydraulic rewind drives contribute much to the efficient surface, differential or center winding of this fast-operating machine. No power is wasted. Maximum rewind shaft driving torque is set manually for each type of winding. Varying power demand of the rolls controls the speed of the hydraulic motors to automatically adjust the delivery of the variable delivery pump to the exact system requirement. Specially adjustable Vickers Relief Valve permits slow speed starting to avoid tear.

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Vickers Variable Delivery Piston Type Pump with pressure compensated control—delivery is automatically regulated by signal pressure change at compensator. Capacities from 5 to 350 hp.

Vickers Constant Displacement Piston Type Hydraulic Motor. Torque is preselected by manual adjustment at the pump.

Vickers Balanced Piston Type Relief Valve

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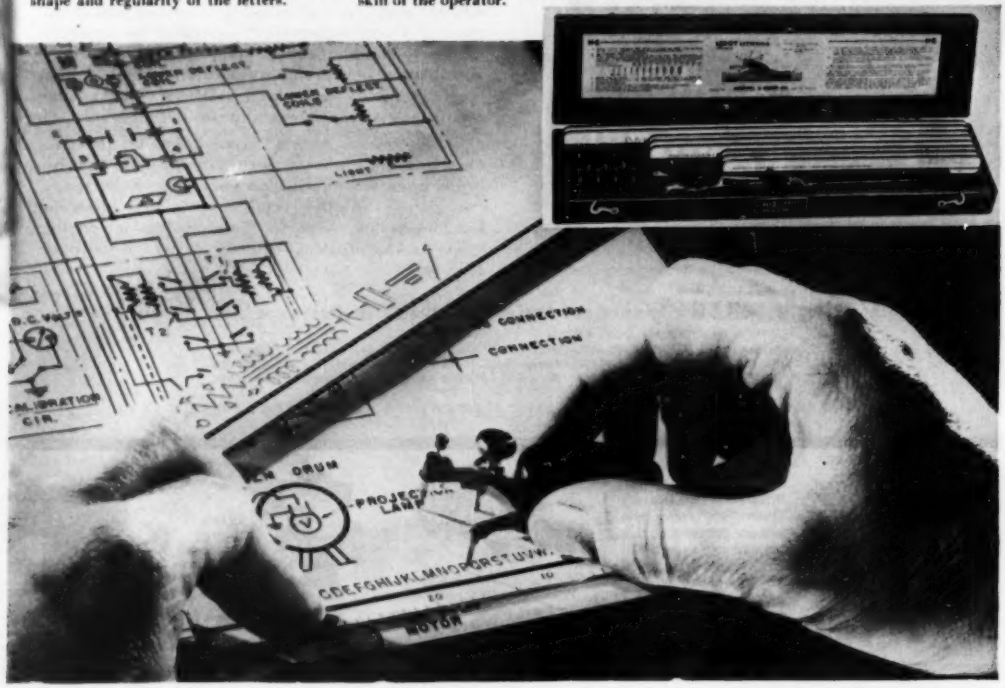
4767

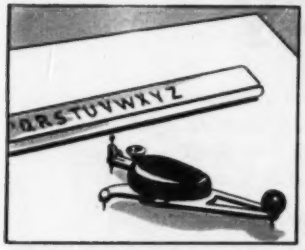
If the results of freehand lettering were always something to be proud of, there would be little or no need of special lettering aids. But as draftsmen know, freehand lettering is often irregular in appearance, and seldom can two men in a department letter exactly alike. Even as simple a device as a height guide helps considerably. Yet it fails in the important function of controlling the shape and regularity of the letters.

An obvious way of controlling shape as well as size is to use a stencil guide. To avoid the broken lines characteristic of stencils, guides were first devised consisting of cut-out portions of letters which could be combined to compose complete letters. However, they covered the work in progress, obscuring it from view, and the appearance of the finished lettering still depended largely on the skill of the operator.

To afford greater control, a stencil guide was developed on which all but a few letters were complete in outline. Shifting the guides with a shuttling motion permitted the breaks in the lines to be filled in. Like all stencils, these too covered up the lettering, and they also had to be supported slightly above the drawing surface so they could be shifted without smearing the work.



The Right Angle



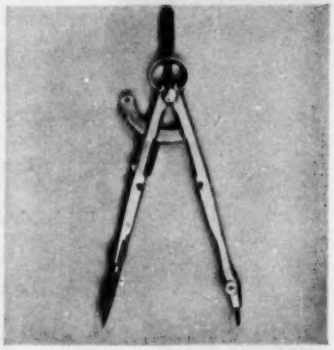
Instead of stencils, the LEROY Lettering Set has templates with grooved characters which guide the pen virtually by "remote control". In place of a hand-held pen, there is a movable scriber. It combines a lettering pen, a pin that fits in and follows the grooved characters, and a sliding pivot, and it holds them in triangular relationship. Because a straight groove in the template restricts the motion of the pivot, the movement of the pen is governed entirely by the movement of the tracer pin.

With the LEROY scriber, the lettering is done above the template where it is always visible and safe from smearing, instead of through a stencil. Each letter, numeral or symbol is formed completely with unbroken lines, without moving the template. Its size and shape are entirely controlled by the template grooves, so that rapid, uniform lettering is easy. By a simple adjustment of the scriber, either vertical or slant lettering is possible from the same template.

With a LEROY Lettering Set, you can draw capitals, lower case letters and numerals from a single template. You can form perfect letters on the first trial, and can develop speed with a few minutes' practice. No guide lines, no "roughing in", no erasing. You can be sure of uniformity throughout the drafting room, in pencil or ink.

There are LEROY templates and pens for every size and thickness of lettering normally required, as well as templates with engineering and scientific symbols and with special alphabets. K&E can also produce special templates for phrases, symbols or trade marks of your own design.

Ask your K&E Distributor or Branch to tell you about other LEROY features, or write to us for complete booklet on LEROY.



You will find "Quick Set" the handiest large bow combination you've ever used. It has a trigger-quick action for coarse settings plus micrometer adjustment for precise settings. Complete with interchangeable pen and pencil inserts for circles up to 12½" diameter in pencil and 12" diameter in ink.

Cut down on the clean-up with an ABC* Dry Clean Pad. Tiny gum eraser particles sift through the mesh of the pad. Sprinkle them in a light film over the drawing surface before starting work and you'll have no graphite smears. Use it the same way for final clean up. Contains no grit or abrasive.

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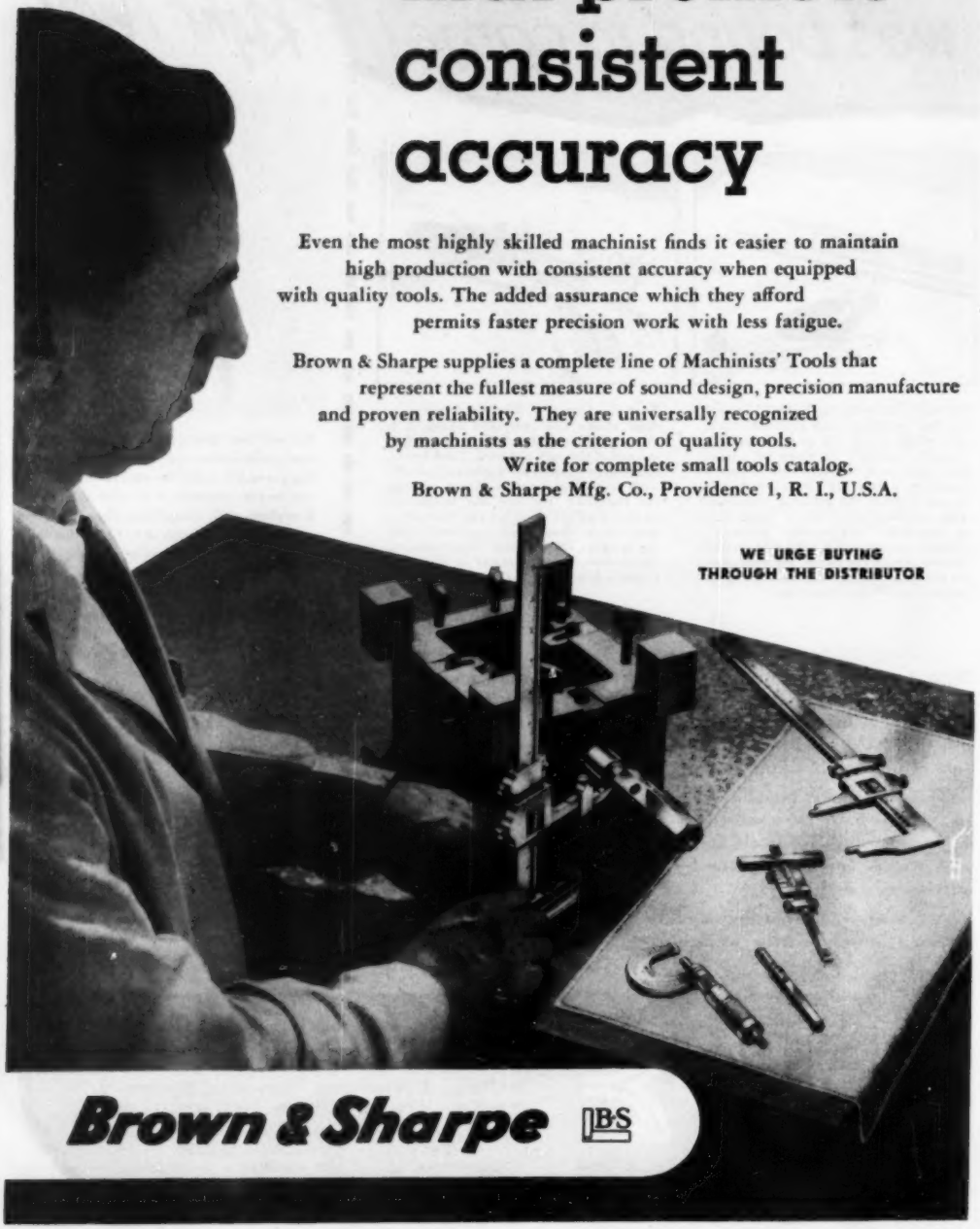
K+E

fine tools that promote consistent accuracy



Even the most highly skilled machinist finds it easier to maintain high production with consistent accuracy when equipped with quality tools. The added assurance which they afford permits faster precision work with less fatigue.

Brown & Sharpe supplies a complete line of Machinists' Tools that represent the fullest measure of sound design, precision manufacture and proven reliability. They are universally recognized by machinists as the criterion of quality tools.

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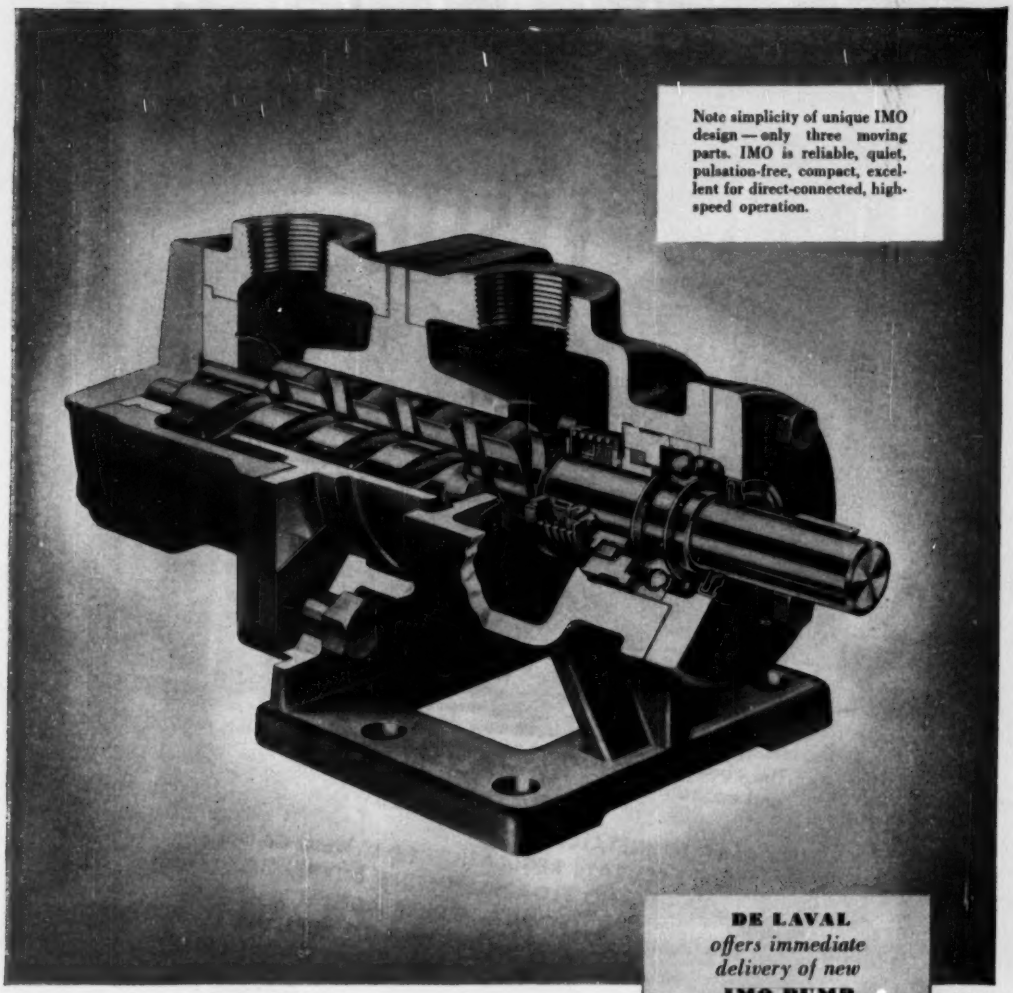


Note simplicity of unique IMO design — only three moving parts. IMO is reliable, quiet, pulsation-free, compact, excellent for direct-connected, high-speed operation.

DE LAVAL
offers immediate delivery of new
IMO PUMP
Write today

DL 147

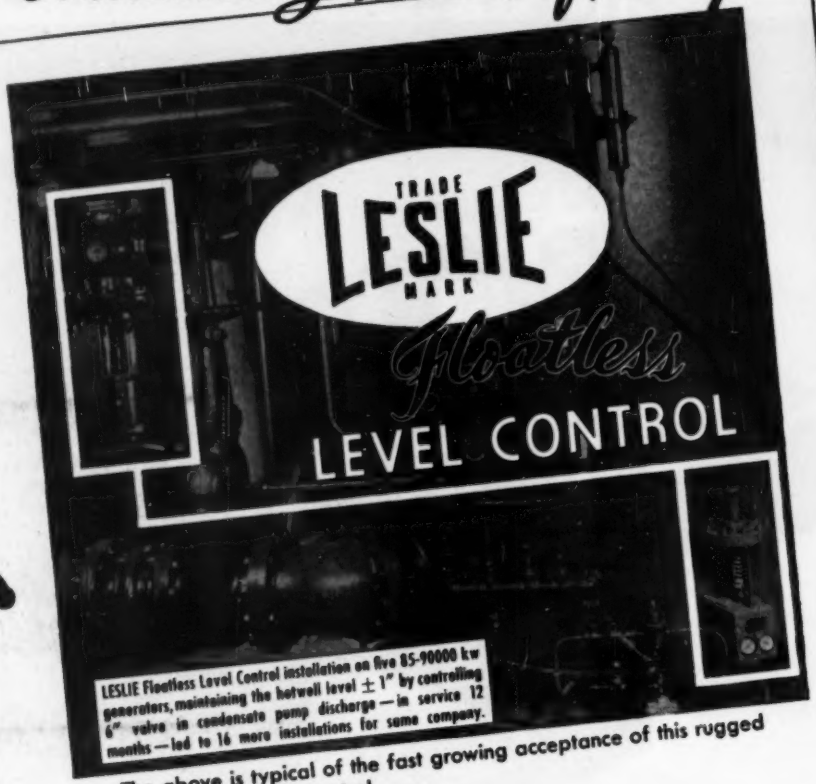
This newest De Laval IMO pump — Model A313B — can be used profitably on a wide variety of hydraulic applications for higher pressures. Quantity-produced to help trim your costs, the new IMO saves you up to 40% in initial cost over other IMO models for pressures up to 275 psi. In addition, this quality-designed rotary positive displacement pump gives you all the low-maintenance advantages of the famous IMO pumping principle.

Put the new De Laval IMO A313B pump to work handling light or viscous fluids in hydraulic systems, rotary and steam atomizing oil burners, lubrication, governing systems and similar services. Specify it for capacities to 80 gpm, pressures to 275 psi and intermittent pressures to 325 psi.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY
Trenton 2, New Jersey

An Outstanding Record of Acceptance!



LESLIE Floatless Level Control installation on five 85-90000 kw generators, maintaining the hotwell level ± 1" by controlling 6" valve in condensate pump discharge — in service 12 months — led to 16 more installations for same company.

The above is typical of the fast growing acceptance of this rugged and accurate level control.

ADVANTAGES

- EASY TO INSTALL
- ACCURATE REGULATION (± 1" Water Column)
- NO FLOATS, STUFFING BOXES, ETC.
- MULTI-MEDIUM ACTUATED
- DIAPHRAGM PRESSURE ELEMENT
- ACTION REVERSIBLE

Applications: On open and pressurized vessels, including boilers, tanks, evaporators, heaters, standpipes, etc.

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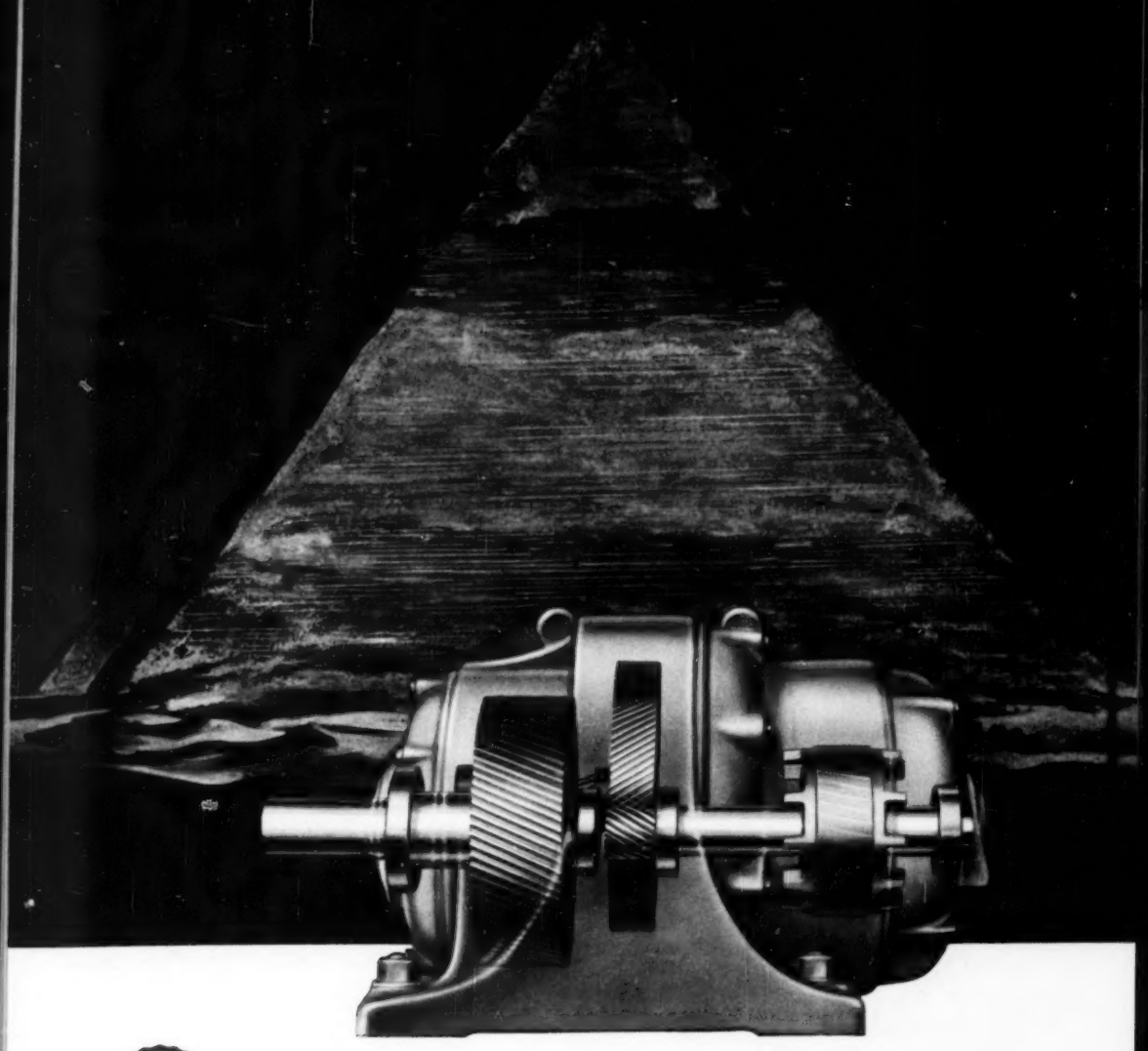
SEND for **Illustrated Bulletin**

Look for LESLIE Regulators under "Valves" or "Regulators" in your Classified Telephone Directory in leading industrial cities where LESLIE factory-trained engineers are located.

LESLIE CO., 287 Grant Avenue, Lyndhurst, New Jersey 1627

PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS • FLOATLESS LEVEL CONTROLS
PUMP GOVERNORS • TEMPERATURE REGULATORS
SELF CLEANING STRAINERS • AIR HORNS • STEAM WHISTLES

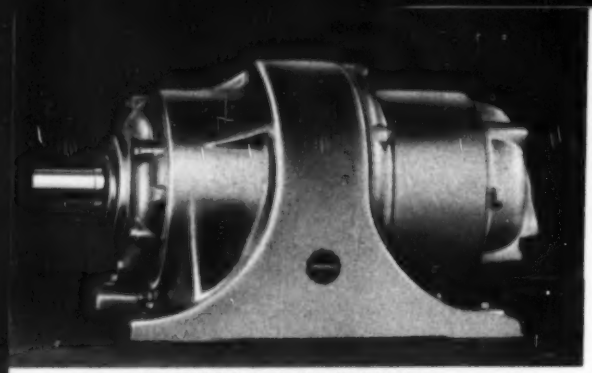
DURABILITY



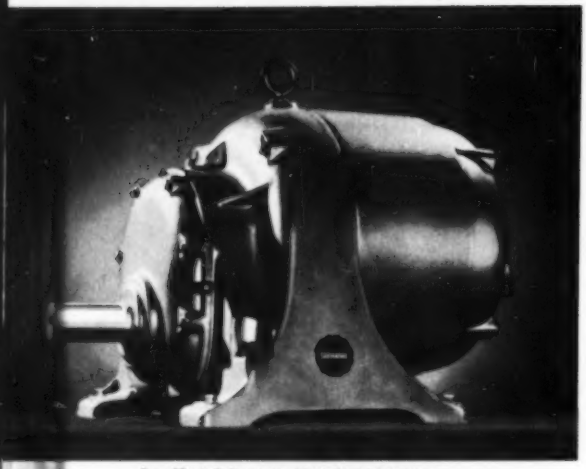
U.S. MOTORS

U. S. SYNCROGEAR MOTOR

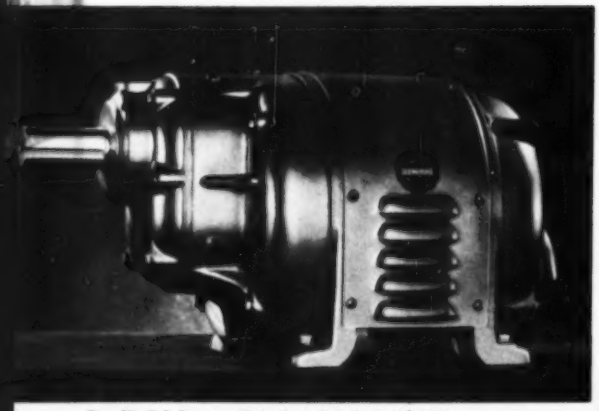
The internally-geared motor with **PYRAMIDAL** *stability*



Type GD – U. S. Syncrogear Motor, Double Reduction



Type GR – U. S. Syncrogear Motor, Single Reduction



Type GK – U. S. Syncrogear Motor, Single Reduction and Speed Increaser

SIMPLIFY

WITH

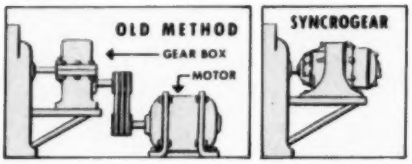
SYNCROGEAR

THE INTERNALLY-GEARED MOTOR

When you need geared power for slow speeds or heavy loads, use this simple hook-up—the *U. S. Syncrogear Motor.* Instead of installing a motor plus gear box or exposed gears, extra coupling and belting, you can direct connect this motor.

The Syncrogear motor is internally-geared within a pyramidal structure which is extremely rigid. Gearing is maintained in perfect alignment and completely enclosed within a sealed housing, protected from dust, dirt and other contaminants. All castings are normalized. The motor windings are asbestos-protected to resist carbonization. The gears are hardened to Rockwell C 45/50 to insure longest life. Dip-splash lubrication automatically feeds the correct amount of lubricant and insures cool gear operation regardless of load.

SAVE SPACE



Note the compact setting of the U. S. Syncrogear Motor. It occupies practically no more space than a standard motor. Its integral design saves space so that equipment designers can reduce over-all dimensions and eliminate extra gearing and intermediate connections.

U.S. MOTORS

U. S. ELECTRICAL MOTORS INC.

PACIFIC PLANT: Los Angeles 54, Calif. (P. O. Box 2058).
ATLANTIC PLANT: Milford, Conn.

Atlanta 3, Ga.; Bakersfield, Calif.; Boston 16, Mass.; Chicago 8, Ill.; Cincinnati 16, Ohio; Cleveland 14, Ohio; Dallas 9, Texas; Detroit 2, Mich.; Fresno 1, Calif.; Houston 4, Texas; Indianapolis 4, Ind.; Milwaukee 2, Wisc.; Minneapolis 2, Minn.; New York City 6, N. Y.; Philadelphia 2, Pa.; Pittsburgh 2, Pa.; San Francisco 7, Calif.; Seattle 4, Wash. Sales and Service offices in all principal cities.

U. S. Electrical Motors Inc.
Box 2058, Los Angeles 54, Calif. or Milford, Conn.

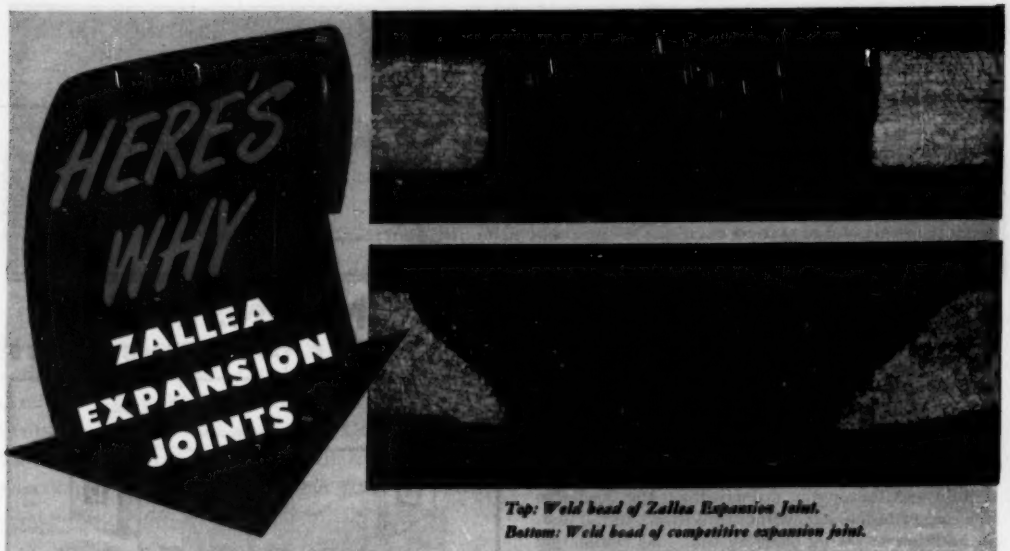
Send your new Bulletin illustrating and describing Syncrogear Motors. ☐
Also General Bulletin of all U. S. Motors. ☐

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____



Top: Weld bead of Zallea Expansion Joint.
Bottom: Weld bead of competitive expansion joint.

...Offer You Longer Service Life!

For years, expansion joint manufacturers have talked in general terms about "quality", "dependability", "economy", and the like. But these words have no real meaning to you as a user of expansion joints unless they are backed up by facts... and conclusive proof!

When we point out that Zallea Expansion Joints offer you *longer* service life, here's what we mean:

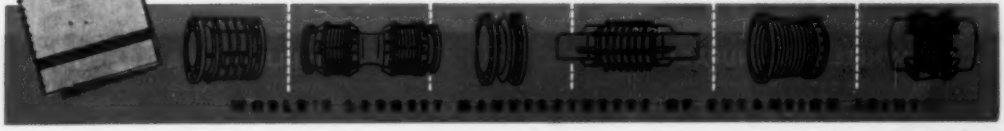
It's an accepted fact that the life of a corrugated expansion joint varies inversely with the thickness of the metal. Therefore it is essential that a corrugated bellows have uniform thickness throughout. Only in Zallea Stainless Steel Expansion Joints are you assured of this optimum condition because Zallea alone produces a longitudinal weld of the same thickness as the parent metal without grinding.

Accelerated flexing tests of many corrugated bellows proved that the resultant welding bead of a shielded arc weld was detrimental to the life of the bellows because failure always occurred across the weld—thickest section of the bellows. Zallea metallurgists analyzed many welding processes and found that by adopting an exclusive variation of the Heliarc process and adding a grain refining procedure to the finished weld, they could produce a corrugated bellows that under brutal flexing tests to destruction, *failed in the parent metal only.*

In over 100 bellows tested with Zallea controlled welding, not one failure occurred within 30 degrees of the weld line. More important was the fact that these bellows lasted as much as *8 times* longer than bellows having a shielded arc welding bead! Compare these two unretouched photomacrographs. See for yourself why it is to your advantage to buy Zallea when you want the best in expansion joints. Zallea Brothers, 820 Locust St., Wilmington 99, Delaware.

For complete information on all Zallea Expansion Joints, write for Catalog 47. You'll also want a copy of Bulletin 351 for quick reference. Ask for it too!

Zallea
EXPANSION JOINTS



NOTES for the Power Engineer

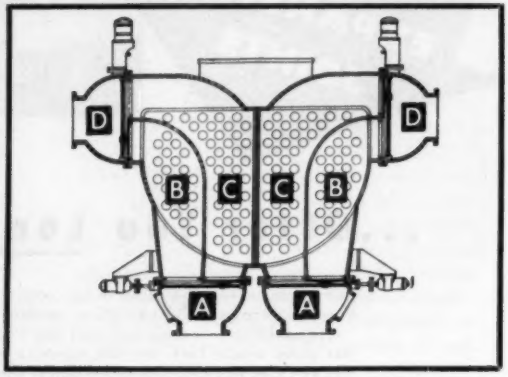
C. H. Wheeler OF PHILADELPHIA

STEAM CONDENSERS—STEAM JET EJECTORS—COOLING TOWERS—VACUUM REFRIGERATION—HIGH VACUUM
PROCESS EQUIPMENT—MICRO-PARTICLE REDUCTION MILLS—MARINE CONDENSERS & EJECTORS—DECK MACHINERY

"REVERSE FLOW" CONDENSERS

SOLVE YOUR CLEANING PROBLEMS—REDUCE OPERATING COSTS

These advantages are possible only in C. H. Wheeler's unique design of an integral reverse-flow steam condenser. By an arrangement of electrically or hydraulically controlled sluice gates, the flow of water through the condenser tubes is reversed. Refuse is rapidly and thoroughly flushed down the discharge in a matter of minutes, without shutdown of the unit. In addition to saving cleaning time and eliminating labor costs, you improve the efficiency of the whole unit by not reducing load. The need for expensive mechanical water straining apparatus is also eliminated. Reverse-Flow may be incorporated in either divided or non-divided water boxes.

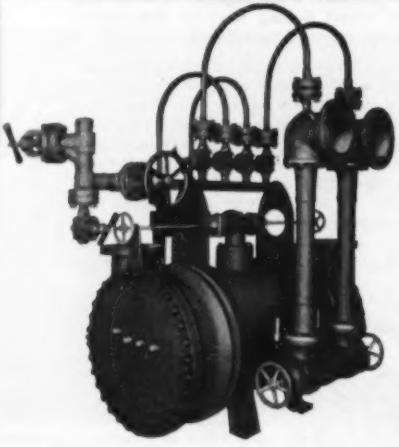


CROSS-SECTION DUAL BANK CONDENSER SHOWING HOW "REVERSE FLOW" WORKS

Both halves work the same but independently of each other.

Right Side: Water enters divided water box at valve chamber D, with lower port open. It flows through pass B to end of condenser, back through pass C and out through left port of A.

Left Side: Flow is reversed: Valves at inlet D and discharge A are changed to permit water to flow through C and back through B in the opposite direction, then out through lower port of A.



SPECIAL TYPE TUBEJET VACUUM PUMP FOR HIGH PRESSURE AND HIGH SUPERHEAT

"TUBEJET" VACUUM PUMPS INSURE LOWEST MAINTENANCE FOR YOUR STEAM CONDENSERS

C. H. Wheeler Steam Jet Ejectors are the development of 35 years of pioneering in this field. Known as "Tubejets," these vacuum pumps have no moving parts. Hence, they are simple to operate, require almost no maintenance and last longer. Modern Power plants use single or two-stage Tubejets with surface inter-after condenser for the vacuum requirements of steam condensers. Special arrangements of standard Wheeler ejector assemblies can be provided for any unusual installation or performance requirements. Catalog #1462 gives you detailed descriptions and some useful temperature and pressure conversion tables. Write for it.

C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Cooling Towers • Vacuum Refrigeration
High Vacuum Process Equipment • Micro Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery

EVERY PLANT ENGINEER SHOULD KNOW

The Great Variety of Uses for Diamond Roller Chains

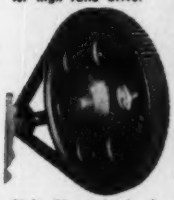
For Miscellaneous Plant-Built Equipment

Flexibility and ease of application,—coordinating and driving a number of shafts in same or opposite direction,—transfer of power from one shaft to several,—all these are yours via Diamond Roller Chains. Speed ratios desired can be attained by selection of sprocket sizes to meet all requirements.

Left: Large Ratio Drive from floor above.

Above: Diamond Drives arranged to give very low final speed.

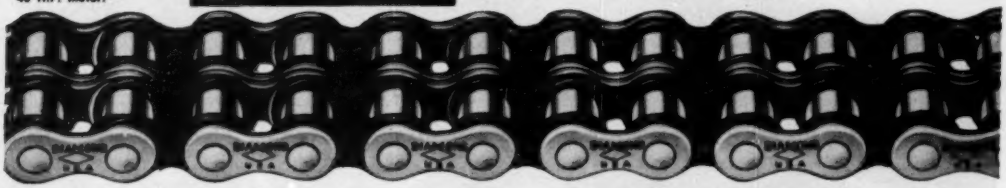
Below: Diamond short-center high ratio Drive.



Right: Diamond Drive from 40 H.P. motor.

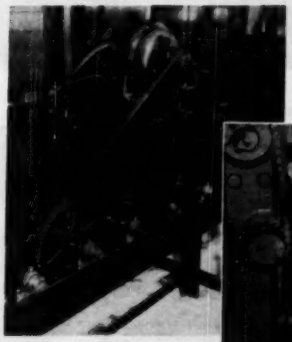
For Motor Drives

High Efficiency Power Transfer, 98-99% . . . Positive, No Slip . . . High or Low Speeds . . . Very Small or Large Horsepowers . . . Short or Long Centers . . . Small or Great Ratios . . . Quiet Operation, and . . . Long-Life Dependability.



For Conveying Systems

Standard pitch size chains without or with various types of attachments are employed in a great variety of ways on conveying, materials handling, timing equipment. The long-life dependability, precision accuracy, uniformity of quality and great reserve strength of Diamond Roller Chains have made them first choice by experienced maintenance and machinery men.



Left: Main drive from motor with series of shaft-to-shaft drives.

Below: Diamond Chain on box making machine

DIAMOND CHAIN COMPANY, Inc.

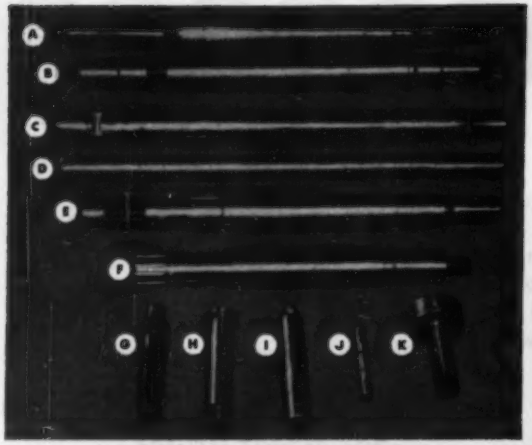
Dept. 413, 402 Kentucky Avenue, Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

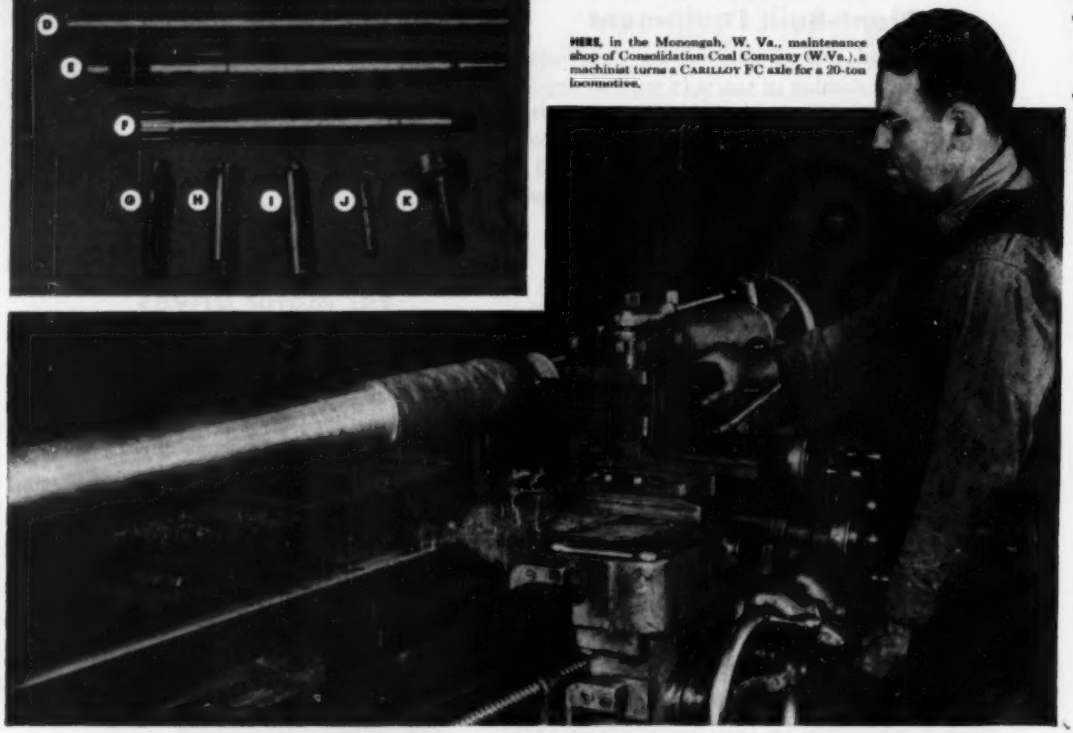
DIAMOND ROLLER CHAINS

Heavy-duty axles and shafts

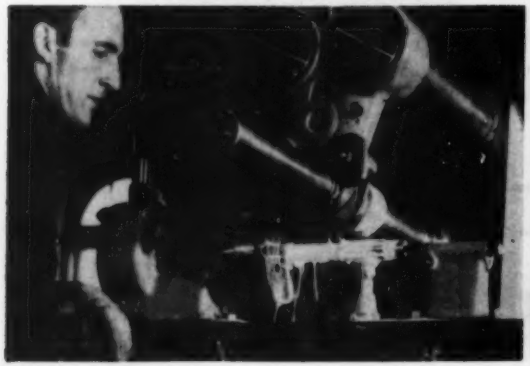


CARILLOY FC is used in machining this great variety of parts. Notice the diversity of applications handled by one grade of alloy steel: (A) is an armature shaft. The following parts are for loading machines; (B) loading clutch shaft, (C) conveyor take-up shaft, (D) conveyor hinge pin, (E) transmission clutch shaft, (F) caterpillar drive axle, (G) caterpillar idler axle, (H) sprocket shaft, (I) caterpillar take-up shaft, (J) hydraulic pump shaft, (K) caterpillar take-up screw.

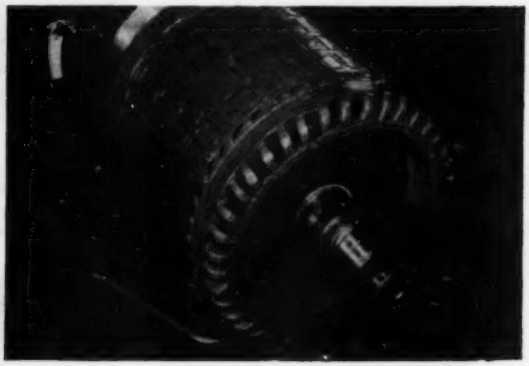
HERE, in the Monongah, W. Va., maintenance shop of Consolidation Coal Company (W.Va.), a machinist turns a CARILLOY FC axle for a 20-ton locomotive.



CARILLOY speeds up milling of a loading machine shaft.



THE SHAFT for this 1800-pound locomotive armature was machined from CARILLOY FC and put into service without heat treatment.



made without heat treating

with pre-hardened free-cutting

CARILLOY FC STEEL

EVERY year, over 5 million tons of coal pour out of the 6 Fairmont, West Virginia, region mines of Consolidation Coal Company (W. Va.). All repair and rebuilding of the hard-working equipment used in these mines are done at the company's Monongah, W. Va., maintenance shop.

Here, highly skilled machinists make everything from mine locomotive axles to armature shafts. Each new part they make must be as strong as the original, without benefit of heat treatment after machining.

So here is just the place for a very special kind of alloy steel.

Consolidation Coal Company (W. Va.) has found that they can produce practically all of the heavily stressed parts they use in their own shops—without heat treating—with a special grade of alloy steel, such as U·S·S CARILLOY FC steel. This pre-hardened, free-cutting alloy steel is received from the mill already quenched and tempered to the hardness required. No further heat treatment is necessary. Finished parts have a minimum tensile strength of 140,000 psi. and good surface finish.

U·S·S CARILLOY FC offers you important advantages if you have to make heavy-duty shafting or other parts that require 125,000 to 175,000 psi. steel. This deep-hardening manganese, chromium, molybdenum alloy steel is available quenched and tempered from 255 to 375 Brinell. You don't have the expense of heat treating after machining and you eliminate rejects caused by distortion and scaling.

For *production* work, remember that CARILLOY FC, easy to machine, is easy on your tools—some users report that tools last 300% longer, and more pieces can be produced per hour.

CARILLOY FC is available now, quenched and tempered *or* annealed, in all standard bar forms and sizes.

It costs only slightly more than ordinary through-hardening alloy steels.

UNITED STATES STEEL COMPANY, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

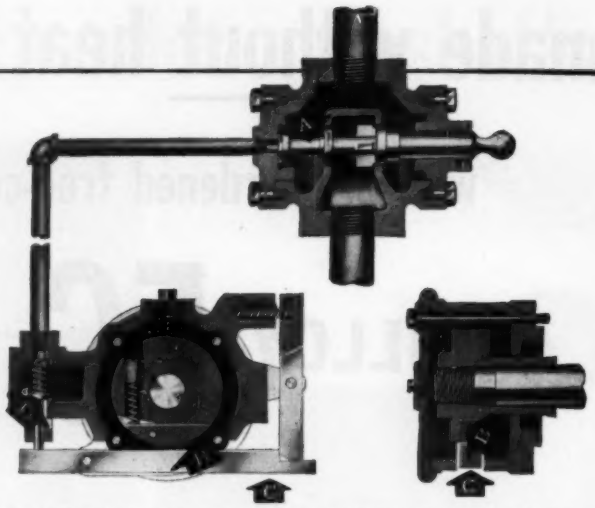
Carilloy USS Steels

ELECTRIC FURNACE OR OPEN HEARTH

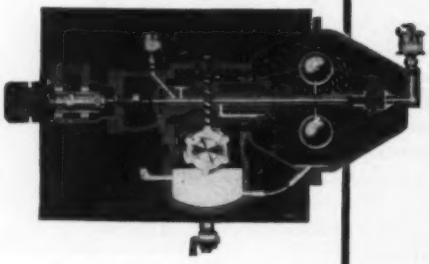
COMPLETE PRODUCTION FACILITIES IN CHICAGO OR PITTSBURGH

UNITED STATES STEEL

Only Coppus Turbines offer you *a pilot operated* excess speed safety trip



The constant speed governor on Coppus Turbines, plus this Excess Speed Safety Trip, gives you extra protection for your turbine investments. Here's how it works. When steam is turned on, pressure opens valve A fully. When excess speed is reached, centrifugal force throws weight B against lever C lifting pilot valve D. This releases pressure in back of valve A, closing this valve instantaneously, to shut off the steam. Safety trip can be tested easily while turbine is running by manually tripping and resetting lever C.



Sectional view showing lubricating system of fully enclosed Coppus Constant Speed Governor. Governor head acts directly on stem of steam admission valve. No external levers required. Ball bearing construction eliminates end play and gives frictionless operation.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

CUT YOUR COSTS PER HORSEPOWER

When you choose from the Coppus Steam Turbine line, you get the right size for your requirements . . . and make substantial savings on *any* size from the 150 hp turbine down to the smallest. Low in first cost, Coppus Turbines save you more money in the long run. Operating and maintenance costs are kept low by such other features as: large number of steam nozzles, controlled individually by manually operated valves; hard chromium plating on shaft at the stuffing box; replaceable cartridge type bearing housings; optional carbon ring packing assembly for back pressures up to 75 pounds.

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORPORATION, 366 Park Ave., Worcester 2, Mass. Sales offices in THOMAS' REGISTER.

COPPUS "BLUE RIBBON" TURBINES

Protect Costly Equipment With TDA BRAKES

When you're lifting vital defense material that's both heavy and breakable, it's only good sense to do the job with equipment that's tested and proved in every respect! That's why so many manufacturers of rubber-tired cranes used in this type of work have standardized on TDA Brakes for all their vehicles. For example, the Thew Shovel Company of Lorain, Ohio—makers of the crane shown here loading aircraft engines essential to America's defense—has used TDA Brakes exclusively since it built the very first rubber-tired crane in 1918. And throughout the nation, there are more TDA Brakes in actual use on heavy-duty commercial vehicles than any other make! TDA is America's greatest name in brakes!

TIMKEN Detroit BRAKES
TDA BRAKE DIVISION
THE TIMKEN-DETROIT AXLE COMPANY
ASHTABULA, OHIO
The Accepted TDA Standard
TRADE MARK REGISTERED

WHATEVER YOUR BRAKING PROBLEM—TAKE IT TO TDA!

TDA BRAKE DIVISION—DEPT. 4D, ASHTABULA, OHIO

Please mail brake information on these applications:

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The Smoothest DRIVE---

LORD

Shear-Type Flexible Couplings

There is the bonded-rubber flexible coupling service that you may need . . . the result of analyzing specific coupling requirements.

Lord Shear-Type Flexible Couplings deliver the smoothest power because of the torsional softness of elastic materials stressed in shear. This softness cushions the shocks of starting and stopping . . . it prevents the transfer of shock loads to bearings and gears . . . places natural frequencies beyond operating speed ranges . . . acts as a mechanical fuse to disconnect equipment under overload or stall conditions.

Lord Shear-Type Flexible Couplings are engineered specifically for the work they must do . . . they prolong the service life of driven equipment . . . operate quietly . . . need no lubrication . . . prevent transmittance of noise between shafts . . . cannot be damaged by dust, dirt, abrasives.

For smooth, noiseless, uniform drive, there is a Lord Flexible Coupling from 1/50 to 100 hp. @ 1750 r.p.m. that will pay you a handsome profit.

Before selecting a coupling for your requirement consult with your Lord Engineer. Write or call—

PHILADELPHIA 7, PENNSYLVANIA
725 Widener Building
LOcust 4-0147

DETROIT 2, MICHIGAN
7310 Woodward Ave.
TRinity 5-8239

DAYTON 2, OHIO
238 Lafayette Street
Michigan 8871

BURBANK, CALIFORNIA
233 South Third Street
ROckwell 9-2151
CHurleston 6-7481

CHICAGO 11, ILLINOIS
520 N. Michigan Ave.
Michigan 2-6010

NEW YORK 16, NEW YORK
280 Madison Avenue
MUrray Hill 5-4477

DALLAS, TEXAS
1613 Tower Petroleum Building
PRospect 7996

ERIE, PENNSYLVANIA
1635 West 12th Street
3-2296

LORD MANUFACTURING COMPANY • ERIE, PA •

LORD BONDED RUBBER

HEADQUARTERS FOR
VIBRATION CONTROL MOUNTINGS
. . . BONDED RUBBER PARTS

Lord Engineering and Design Service Fits The Flexible Coupling To The Specific Job

"Rubber in Shear Bonded to metal offers the user of flexible couplings more for his money than any other material." Lord Engineers take advantage of this statement by offering industry shear-type flexible couplings for a wide range of duty. Since most couplings are purchased on price it is necessary to understand the values inherent in the product of the Lord Engineering Organization. There are 3 main points of superiority in Lord Shear-Type Flexible couplings: One, each Lord design performs a specialized function, "fits the job" . . . Two, they can be made to conform to small clearances . . . Three, they are attached to the driving and driven shafts with minimum effort. Lord

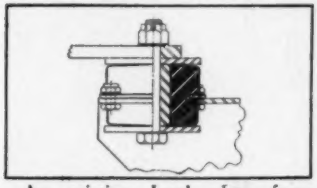
Shear-Type Flexible couplings are so designed that lubrication is not necessary. There are no wearing surfaces. In consequence dust, dirt and abrasives have no effect upon Lord Flexible Couplings. Silent operation results from the use of elastic materials bonded to metal hubs. There are no moving parts to chatter. The rubber also dampens any noises which could be transmitted between driving and driven shafts. An outstanding value is inherent in the use of bonded-rubber in shear which acts as a mechanical fuse to disconnect the shafts before permitting breakage, due to overloads.

The Torsional softness of elastic materials stressed in shear insures smooth power delivery, cushions shocks of starting and stopping, prevents transfer of shock loads to bearings and gears.

Lord Shear-Type Flexible Couplings are widely used today by motor car manufacturers on convertible top and window lift mechanisms. The operation of home appliances, pumps, and internal combustion engines is improved by their use.

Railroad Equipment Protected By Lord Mountings

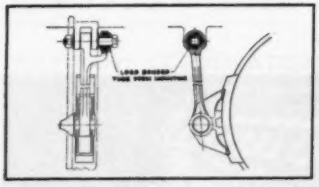
A special plate form mounting has been designed by Lord Engineers for use as a shock mounting for engine-generator and motor-compressor units installed on railroad rolling stock. The problem was to design a Lord Mounting which would minimize the shocks of coupling and uncoupling cars and thus prevent damaging the undercar equipment referred to above.



An existing Lord plate form mounting design was utilized with a steel tubing insert in the elastomer to increase the stiffness of the mounting. Tooling and research expense were thus saved by this unusual application of Lord Mountings previously designed to solve another similar problem.

Excessive Wear Eliminated By Use of Lord Mountings

A recently designed Lord Mounting has solved a problem for a manufacturer of brake assemblies in the railroad field. A Lord Tube Form Mounting design was utilized as a joint for the brake hanger mechanism. Through the use of rubber bonded to metal sufficient motion was permitted to compensate for shock while eliminating wear on the pin and joint at the point of motion.



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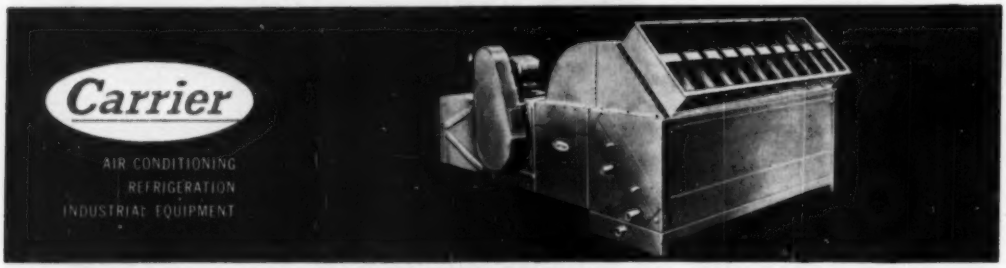
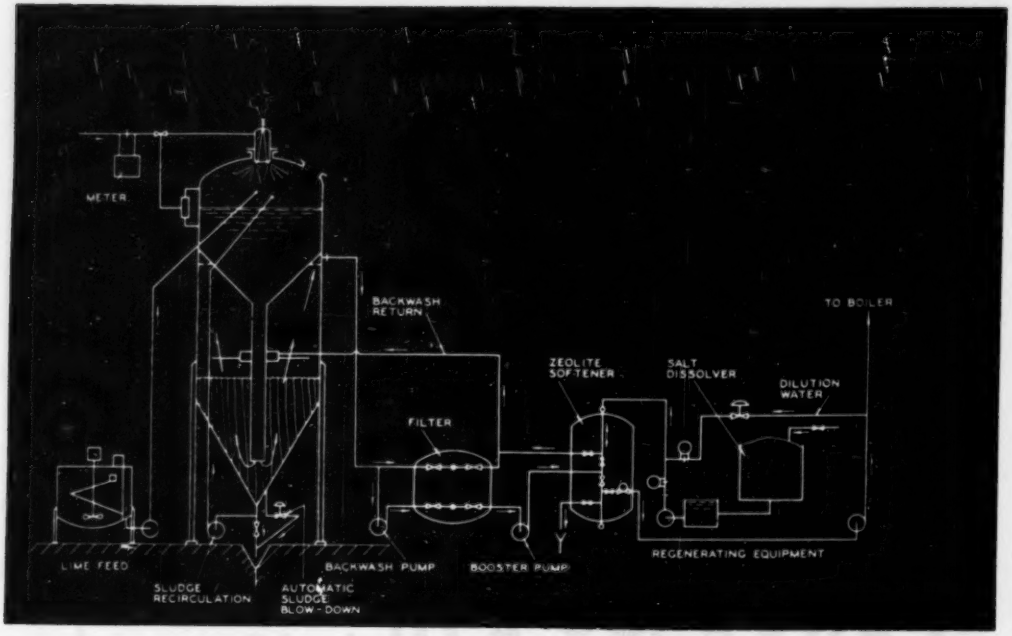
This new Weathermaker joins Carrier's great family of products . . . products matched in size and performance to work together . . . products to meet every industrial or comfort air conditioning requirement you have. Carrier Corporation, Syracuse 1, N. Y.



The Carrier Zoning Weathermaker, available in 5 sizes with cooling coils in 4 or 6 row direct expansion . . . or 4, 6 and 8 row cooling coils for brine or chilled water. Cooling capacities from 15 to 80 tons, 4100 to 16,400 cfm.



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1. saves chemicals
The zeolite softener uses salt instead of the more expensive soda ash and phosphates, bringing down the cost of chemicals considerably.

2. saves on capital investment The cost of adding zeolite equipment to a hot process installation is far less than the addition of an independent sedimentation tank and chemical feed for a two-stage phosphate process.

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The lower alkalinity resulting from using lime alone, plus the fact that this alkalinity is all carbonate, causes a reduction in CO_2 generated in the steam.

4. less operating attention The use of the zeolite softener with its simplicity of operation is an advantage which is enhanced by the longer periods between regenerations, due to the lower hardness of the hot process softener effluent.

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The addition of the zeolite equipment requires less floor space and less head room than that required for two stage phosphate equipment.

6. lower alkalinity The use of lime (or Dolomitic lime) as the sole reagent in the hot process means that the alkalinity can be reduced to about half that obtained with lime and soda ash.

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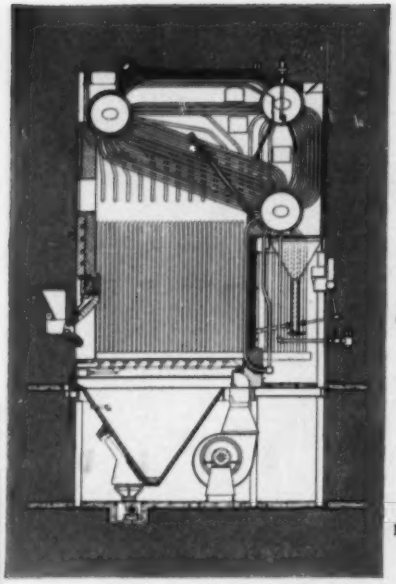

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Saved $68,670 in 12 months

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1951 SAVINGS

	Savings
Coal for 1951	10,682 Tons
Fuel Cost	$38,578
Operating Labor	$ 9,353
Service Dept. Charge	$ 4,677
Repairs & Maint.	$16,062
1951 Savings	$68,670

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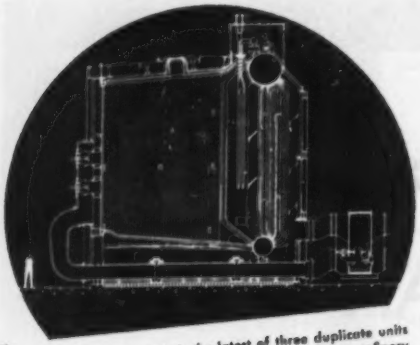
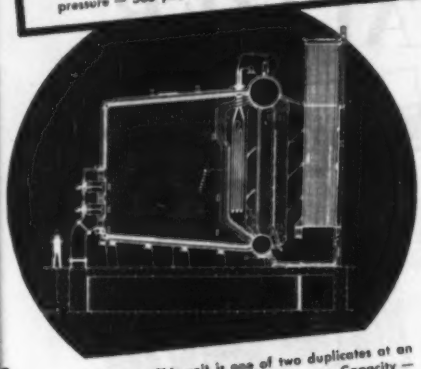
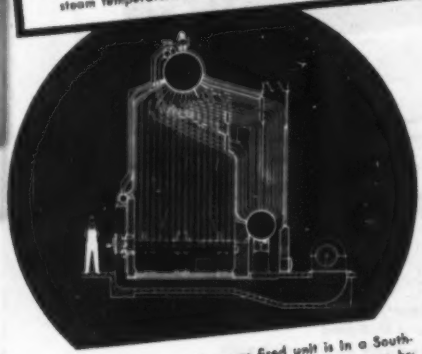


VU-50 Boiler — This is the latest of three duplicate units installed in this Western plant. Fired with oil or refinery gas. Capacity — 250,000 lb of steam per hr; operating pressure — 565 psi; steam temperature — 650 F.



VU-50 Boiler — This unit is one of two duplicates at an Eastern plant. They are fired with oil or gas. Capacity — 100,000 lb of steam per hr; operating pressure—550 psi; steam temperature — 700 F.



VU-10 Boiler — This oil or gas fired unit is in a Southwestern plant. Capacity — 60,000 lb of steam per hr; operating pressure — 150 psi; steam temperature — 465 F. VU-10 capacities range from 10,000 to 60,000 lb of steam per hr.

The story's the same, wherever you go . . . in industry after industry . . . wherever steam is used . . . C-E Vertical-Unit Boilers will be found in the plants of many of the leading companies.

The Petroleum Industry, for example . . . one of the largest users of steam for process and power . . . has installed VU Boilers with an aggregate capacity of many millions of pounds of steam per hour. The list below gives evidence of the widespread acceptance of the VU Unit among leaders of the petroleum industry.

Several of these companies have ordered and reordered VU Boilers over a period of years. They know by actual experience what they can expect from a Vertical-Unit Boiler. One company, for instance, ordered its first VU in 1937, its second in 1940, two more in 1942 and another in 1947. A sixth unit was installed in 1950.

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But boat builders filled it. Filled it with a metal that satisfies *their* demands . . . and the strict requirements of the Yacht Safety Bureau. Filled it with a metal that qualifies in every respect for gas tanks, among stock boat builders.

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 74 NUMBER 6

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Collapsible-Type Jet Helicopter Developed by the Army Ordnance Corps of the Department of the Army

(Designated the XH-26, the new helicopter can be dropped from larger planes, unpacked by two men, and put in the air in approximately 20 minutes. It is designed for air evacuation as well as for observation. *Further details appear on page 496 of this issue.**)*

VOLUME 74
No. 6

MECHANICAL ENGINEERING

JUNE
1952

GEORGE A. STETSON, *Editor*

Development Fund

A FEW months ago in this space attention was directed to the ASME Development Fund. Early in the year every member of The American Society of Mechanical Engineers received a brochure describing the purpose of the fund and a letter soliciting contributions to it. It was explained that the fund was being established to permit the Society to advance money for useful projects. It was stated "that the Society, like the individual member, if it is to live up to responsibilities of service beyond obvious obligations to its members and the nation, must have the courage, the zeal, the will, and the facilities to expand its usefulness and venture into fields and projects that should not be financed by dues. The ASME Development Fund exists for this purpose."

As of the date this was written, contributions to the ASME Development Fund amount to about $94,000. Slightly more than $88,000 has been contributed by 186 firms, and something less than $6000 by 300 of the 37,000 members of ASME. These figures indicate a member contribution averaging about $20.

Because individuals were not solicited when the "A" Development Fund was raised several years ago through contributions from industry, it is possible that some members have not understood that in the current solicitation for the "B" Development Fund, they, as well as their firms, are being given an opportunity to express their confidence in the work of their professional society by sharing in it in no matter how modest a manner. Individual contributions to date have run all the way from a couple of dollars to a hundred or more. The Committee in charge of raising the fund are quite as much concerned with the number of members who respond to their appeal as they are with the size of their contributions. So this is an appeal for participation by a greater number of members in the ASME Development Fund.

Contributions by ASME members to projects financed by funds not derived from dues is an old and honorable Society tradition. In 1884, during the first decade of the Society's life, with a total membership of 610 and an annual budget of less than $9000, the Committee on Library, appointed June 25, 1884, "to take steps for the foundation of a Library for the Society," reported that 112 members had already contributed $559.40 toward the attainment of that goal. Such was the generosity and enthusiasm of 1884.

It is interesting to note that the Committee's report of 1884 stated that "no dependence upon the ordinary income and funds of the Society should be expected or desired," and "contributions to the Library Fund should be solicited from the entire membership of the Society." These are the principles on which the ASME Development Fund is based.

Contributions in the form of books, periodicals, and other library materials, an increasing number of donations to the permanent library fund, and annual voluntary additions to the dues for an operating fund brought the ASME Library into existence. Its growth soon raised a question of space to house it in the rented quarters of the young Society, so that, within a few years, through the efforts of a group of loyal members, the Mechanical Engineers Library Association was incorporated. With the aid of a bond issue, oversubscribed by ASME members, the first permanent ASME home was purchased and fitted up with offices, a library, an auditorium, and a few sleeping rooms from which income was derived. The newly organized American Institute of Electrical Engineers took office space in the building and used the auditorium for their meetings. Shortly after the turn of the century the plans for an Engineering Societies Building, which resulted in the present headquarters in West 39th St., New York, were given the necessary forward impetus by Mr. Andrew Carnegie's generous gift, and dreams became a reality.

One cannot predict what great projects of the future will be initiated because of the ASME Development Fund but it is reasonable to expect that they will develop if money, faith, and courage are not wanting. It is in support of these future ventures that ASME members are being given an opportunity to contribute through the Development Fund. Can the 37,000 members of ASME today match in the same proportion of individual contributors the splendid response of 1884 when the total membership was only 610?

Chicago—1893 and 1952

THE co-operation of more than fifty engineering societies and organizations in the 1952 Centennial of Engineering at Chicago in September, in commemoration of the founding in 1852 of The American Society of Civil Engineers, recalls another example of such co-operation on the occasion of the Columbian Exposition at Chicago in 1893.

Such events are always foci of common interest and co-operation. They serve to emphasize the essential unity of the engineering profession. In this respect they have been and will continue to be important landmarks of and valuable stimulating experiences in intersociety co-

operation. One recalls, for example, another World's Fair in Chicago, The Century of Progress, in 1933, where, for the first time in thirteen years and the second in their history, the four Founder Societies met simultaneously and their governing bodies and that of the United Engineering Trustees came together for a joint meeting.

More recently Engineers Joint Council has brought together at frequent and regular intervals the presidents and secretaries of these societies, augmented now by the American Institute of Chemical Engineers, in an atmosphere which has resulted in the closest of relationships between these leaders of the profession and, in consequence, an insight into and an understanding of common problems that can be developed best when such conditions prevail. Out of this most recent experiment in intersociety co-operation has come the current program of unification, the first step of which is to enlarge the membership of EJC. Thus unity, which must stem from mutual understanding, confidence, and respect, moves toward consummation.

The idea of unity in the engineering profession is older than most of the events which have marked the fractionation of it which has developed through the formation of new engineering societies. Many of these societies are composed of specialists whose interests are in diverse branches, frequently in new fields, which the older groups find it difficult to develop under their already overburdened programs in the older and well-established fields. To bring all of these societies together has been a long-awaited hope.

Ideas and ideals of intersociety unity were in the minds of men who were themselves responsible for organizing, in 1880, The American Society of Mechanical Engineers. They have been held by influential members of the Society at all stages of its career. They will continue to be held and expressed as long as engineering itself persists. In 1889 several hundred engineers—civils, miners, mechanicals—traveled together in Europe to attend the World's Fair at Paris. So well acquainted did they become with each other and with points of view on common problems, that the desire for the "possibility of some closer union between the engineering societies of the United States" led to the formation of a committee which, it was hoped, would find similar committees of the other societies ready to meet it more than halfway, and to the hope that "ultimately we may find a way of bringing all of these great societies into a common union for all those purposes which are appropriate to all alike." Said one member: "I do not see how we. . .can invite these men (members of foreign engineering societies who had entertained them abroad) over here properly, and have a 'respectable recognition and approval' of that invitation by them, unless it comes from some common source, some kind of a union of societies."

In 1890, at the invitation of the Western Society of Engineers, a conference of fifteen engineering societies and clubs, with the Canadian Society of Civil Engineers, met in Chicago to consider "the establishment of an Engineering Headquarters, and of holding an international congress in Chicago during the Columbian Exposition." Out of this grew a permanent committee, on which ASME was represented. The twenty-seventh meeting of the Society, July 31 to August 5, 1893, was merged into and became the sessions of the Mechanical Engineering Section of the World's Columbian Congress of Engineering during the period of the Columbian Exposition. Toward the expense of an engineering headquarters in Chicago during the Exposition, the societies made necessary contributions. Invitations were issued to engineers in Great Britain and Europe. The seats were removed from the auditorium of the new ASME home in West 31st St., New York, in which the Society maintained a bureau of information and a headquarters for foreign visitors. To meet and converse with visitors unfamiliar with the English language, a linguist was employed as clerk in charge of the bureau from June 1 to September 30. Members who had been entertained by British and French engineers at the time of the excursion to the World's Fair at Paris, subscribed to the entertainment of the visitors; and other funds were received from residents of Chicago, Philadelphia, Pittsburgh, St. Louis, and Washington, cities on the itinerary of the engineers from overseas.

Thus intersociety co-operation at home and the establishment of friendly relations with engineers and engineering societies of other countries were put to the test in 1893. Since then, influences that serve to bring engineers together, both nationally and internationally, have been fostered and advanced by the forward-looking leaders of our profession. This year at Chicago the number of engineering societies participating in the 1952 Centennial of Engineering will be many times the number represented there in 1893. Engineers from Great Britain, Europe, and Latin America will be present.

As a footnote it should be recalled that the Society for the Promotion of Engineering Education (now known as the American Society for Engineering Education) which today exercises a powerful influence in its field and is one of the constituent societies of the Engineers' Council for Professional Development, another outstanding example of intersociety co-operation, was born out of the meetings of Division E (Education) at the World's Engineering Congress of 1893.

Those who take a pessimistic and cynical view of efforts to attain unity in the engineering profession would do well to ponder the long history of the movement and contrast the situation as it is today with what it was sixty years ago. Progress has not been rapid; false starts have been made; schemes have been tried and abandoned. But real developments have taken place, as the records will show. There are those who have refused to give up hope that this year, at the 1952 Centennial of Engineering at Chicago, the current plan for greater engineering unity through the enlargement of Engineers Joint Council may be brought to fruition. If this step is taken, indeed, whenever it is taken, it is likely to be but the beginning of a new phase of a long and gradual development. Many years of discussion, trial, and development lie ahead in any event. But a significant milestone will be reached if the enlarged EJC becomes an actuality at Chicago in September.

BUILDING A COMPANY *With* ENGINEERING GRADUATES

By E. G. BAILEY

CHAIRMAN OF THE BOARD, BAILEY METER COMPANY, CLEVELAND, OHIO, AND VICE-PRESIDENT AND DIRECTOR, THE BABCOCK & WILCOX COMPANY, NEW YORK, N. Y. PAST-PRESIDENT ASME

A TRAINING course in industry for young engineering graduates is an important step in the life of the trainee. It is even more important to the employer company and to industry as a whole. Such a training course should be so conducted that it is the main and preferably the only entrance through which a company receives the talent needed to sustain and extend its usefulness.

The first requirement for conducting a good training course is to select potentially good engineers from schools giving the necessary fundamentals of engineering education. The training course should continue teaching these fundamentals, but they should be directed more specifically toward the industry within which the company operates, and it should acquaint the trainee with the detailed activities of the individual company.

Beyond the training course there are opportunities as well as responsibilities for both employee and employer leading toward advancement and healthy growth. The employee should improve himself through study, reading, advanced scholastic courses, activities within societies of his profession, and above all by performing to the best of his ability the assignments and duties given to him by his employer.

It is the duty of the employer to recognize the capabilities and ambitions of the employees and make available to them as much advancement in responsibility, remuneration, and position as can be justified by the prevailing circumstances and economics of the situation.

If the foregoing plans are properly followed, a company can develop a suitable training course which in turn will develop a healthy company.

ONE CASE HISTORY

The Bailey Meter Company was incorporated Jan. 1, 1916, and began supplying measuring and metering equipment such as fluid meters for steam, water, and gases, draft gages, pyrometers, and the like. The principal product was the boiler meter for recording steam flow and air flow for boiler operation.

In 1919 the company moved from Boston to Cleveland into quarters where the anticipated expansion in manufacturing facilities could be realized. To provide for the attendant necessary expansion in trained engineering manpower, E. A. Hitchcock was employed and became vice-president June 1, 1919. Professor Hitchcock had taught experimental engineering at The Ohio State University from 1893 to 1912, when he became engineer for E. W. Clark Management Corporation.

SELECTION OF ENGINEERING GRADUATES

Professor Hitchcock took charge of the company training course and explained to both professors and students at several schools the plans for the program. Although the company had only 100 employees in mid-1919, 12 engineering graduates and 7 juniors for summer work were recruited from 14 different schools and added to the staff at that time. These engineers attended lectures and were assigned to work in the shop, assembling and calibrating meters, for about one year before their training course was extended to field work.

During the school year of 1919–1920, Professor Hitchcock visited additional schools, and at the end of the academic year the company employed 25 engineering graduates from 14 schools, including two graduates who had worked for the company as juniors the previous summer. Twenty-three juniors from 15 schools were also employed for summer work, making a total of 48 engineers employed from 21 schools. These were added to an organization of 144.

During July, 1920, Professor Hitchcock left the company to accept a call from The Ohio State University as dean of engineering. The training course, however, was well started by him, and it has continued along the same general lines with the numerical results shown in Tables 1 and 2.

It should be remembered that the training course was in operation before the establishment in 1932 of ECPD (Engineers' Council for Professional Development), so that it was necessary to rely entirely upon one's judgment regarding both the schools and the men. Other companies were employing engineering graduates at that time, principally the large electrical-equipment manufacturers and telephone companies. These companies specialized in electrical engineers, while Bailey Meter preferred mechanical engineers. The competition was not great, even though the railroads, steel companies, and other miscellaneous equipment manufacturers were taking some mechanical-engineering graduates.

The company's procedure with respect to the schools was to become sufficiently well acquainted with the dean, department head, and faculty to be able to judge whether the undergraduates were receiving a good start in an engineering education. Some deans recommended that their graduates not go with Bailey Meter Company because it was too small a company; many were sympathetic to our plan and co-operated in every way by scheduling interviews with, and lectures to, their classes. The company offered jobs only to those graduates who were of the opinion that they wished to make a career within the power-generating field, and it was always able to employ as many graduates of good caliber as it felt were needed.

Following Professor Hitchcock's short regime as lecturer to, and educator of, the cadet engineers, as the engineering graduates are called, this work was carried on largely by R. M. Hardgrove and C. C. McClelland, both of whom had been graduated from The Ohio State University after studying under Professor Hitchcock. They had been associated with the author in this work before the company was incorporated and are classified with a few others as pre-cadet engineers.

In a small company where close contact exists between management and all employees, there is less need for formality in the education and training of young engineers than in a large

Contributed by the Education Committee, Management Division, and Junior Committee and presented at the Annual Meeting, Atlantic City, N. J., Nov. 26–30, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

organization. By 1925 the company had a total of 280 employees, of whom 73 were engineers. It was expanding rapidly into the field of complete automatic control of large pulverized-coal-fired boilers as well as developing and selling pulverized-coal feeders, burners, and water-cooled furnaces, and the time had arrived to establish a Department of Education. The late J. C. Albright, University of Illinois, 1920, was the director from 1925 until 1930, and J. F. Luhrs, University of Illinois, 1926, carried on this work until the class of 1942 was completed during 1943. No new engineering graduates were available during the war, but the training course was resumed in 1945 by R. E. Sprenkle, Bucknell, 1917, a member of the first cadet class. He is now director of education, and is assisted by J. H. Dennis, Penn State, 1937.

TRAINING-COURSE OUTLINE

The outline of the present training course of approximately one year's duration is given in appendixes 1 and 2. It has not been changed in principle since its inception, although with the development of new types of equipment, particularly those involving the extensive use of electronics, it has been kept up to date in details.

An important portion of cadet engineering training consists of factory assembly and calibration of meters and control units. Because many new types of equipment have been added through the years, a greater diversity of work in the shop has resulted, thus giving the cadet a much broader experience than originally available. Better to round out his training in other branches of the business, the cadet is often given such assignments as taking inventory, routing parts through the shop, preparing shipping orders, inspecting parts, and the like.

The technical lecture course has also been expanded to encompass new equipment and to include discussions of sales techniques, company policies and procedures, and the solution of practical-application problems. The instructions relating to combustion of fuels, chemical processes, and the like, have been changed progressively to meet the detailed advances in the art.

GROWTH OF ENGINEERING STAFF

The progress in building the company in so far as engineering talent is concerned is shown in Fig. 1. The principal points of interest here are the total number of engineers in the company and the percentage of total payroll they constitute. There is also shown the average annual pay to all engineers, as well as to all employees.

Fig. 1 represents history. It shows some factors which might be considered mistakes and which might possibly have been avoided, but if so, then many other organizations have made, and are still making, the same kinds of mistakes. The plot shows the reduction in employment of graduates in 1921–1923, as given numerically in Table 1. When the short slump which occurred in 1921 reduced sales by about 10 per cent, the company should have continued its planned rate of employment of engineering graduates.

The depression starting in 1931, caused such a profound disturbance in the minds of the management of nearly all industries that many followed the general policy of curtailment. In 1931–1932 nearly 40 engineers were laid off, and the salaries of all retained were reduced. The releases of other employees were proportionately greater than those of engineers, as indicated by the proportion of engineers in the company which rose from about 27 to 34 per cent. Practically no additional engineering graduates were employed until 1935.

During this four-year period sales dropped by more than 50 per cent of the 1927–1930 rate, and the net losses almost equaled the total earnings of the previous five years. Had those 40 engineers been retained, about $430,000 would have been added to the net loss. An alternative would have been to retain all engineers and reduce their average salary from $2600 to $2030 per year, resulting in the same financial loss as that actually experienced. In any event it would have been a good investment to have retained all of those engineers for the time when they were most needed during World War II. The company would have had to keep them busy doing useful and educational work, but this could have been accomplished by undertaking extra research projects.

A note of explanation may be injected here to the effect that it is the practice for Bailey Meter Company, Ltd., of Canada to select engineering graduates from Canadian schools and send them to the cadet engineering course at Cleveland; at the end of the training course these Canadian cadets return to the Canadian company. Table 1 includes all engineers employed, and Table 2 shows their distribution. Other data refer only to the United States company unless otherwise designated.

Some question may be raised as to why as many as 15 per cent of the personnel of the company are engineers while only a few other companies have as many as 6 per cent,[1] the average of over 100 companies employing 38,000 engineers and 2,000,000 total employees being 1.9 per cent engineers to total personnel.

The distribution of engineers throughout the Company is shown in Table 3, which is given in lieu of an organization chart. It will be noted that four of the six executives are engineers, three of whom were cadets or pre-cadets. All branch managers are graduates of the cadet course as are also most of the sales-service engineers staffing the 22 branch offices under their direction. The managers of the sales, engineering, research, design, patent, advertising, production, planning, and education departments, together with their supervisors and other staff members, started their careers with the Company through the medium of the cadet training course. In fact, almost all of the important positions in the Company from supervisors to top executives are filled by engineers who have shown outstanding abilities and aptitudes after completing the cadet training program. Table 3 shows that very few engineering graduates are employed in the manufacturing, design, planning,

[1] "Employer Practice Regarding Engineering Graduates," MECHANICAL ENGINEERING, January, 1948, p. 13.

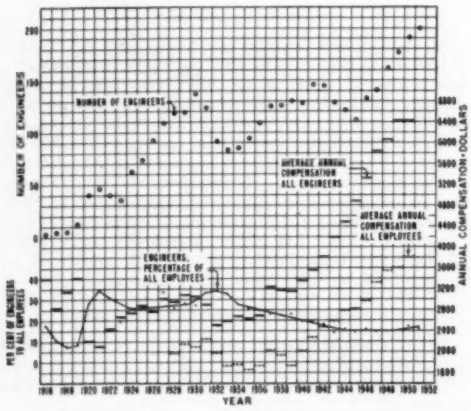

FIG. 1 RELATIONSHIP BETWEEN ENGINEERS AND ALL EMPLOYEES OF BAILEY METER COMPANY WITH RESPECT TO NUMBERS AND COMPENSATION

TABLE 1 STARTING SALARIES FOR ENGINEERING GRADUATES, NUMBER OF ENGINEERING GRADUATES EMPLOYED, ALSO JUNIORS FOR SUMMER WORK

Year	Number of engineering graduates employed	Starting pay per month	Number of schools represented	Number of juniors employed	Rate of pay per month for summer	Number of schools represented
1919	12	$90	8	7	$90	6
1920	25	120	14	23	90	15
1921	16	115	10	22	100	15
1922	5	115	5	7	90	7
1923	12	110	10	18	100	13
1924	18	110	13	22	100	13
1925	14	110	10	16	100	10
1926	19	120	12	1	110	1
1927	29	125	17			
1928	17	125	13			
1929	16	125	12			
1930	25	135	16			
1931	3	118	3			
Total (1919–1931)	211					
1933	1	90	1			
1934	3	90	2			
1935	6	100	5			
1936	18	110	10			
1937	21	110	14			
1938	6	120	6			
1939	11	120	10			
1940	11	120	8			
1941	21	143*	17			
1942	20	161*	13			
Total (1933–1942)	118					
1946	12	202*	8			
1946–1947	13	218*	12			
1947	14	259*	12	2	160	2
1948	35	276*	25	3	170	3
1949	22	276*	18			
1950	21	299*	15			
1951	36	315*	23			
Total (1946–1951)	153					

* Based on 44-hour week.

TABLE 2 SUMMARY OF CADET ENGINEERING TRAINING, BAILEY METER COMPANY 1919 TO 1951

Engineering Graduates

Year	No. employed	BMCo. USA	BMCo. Ltd. Can.	B&W*	Former employees: 1 yr or less	2 to 10 yr	11 to 20 yr	21 to 32 yr	Location of former: Good jobs	Deceased	Unknown
1919–1931	211	45	8	13	61	65	14	5	121	16	8
1933–1942	118	48	6	—	20	42	2	—	52	3	9
1946–1951	153	92	27	—	13	21	—	—	27	1	6
Total, 33 yr	482	185	41	13	94	128	16	5	200	20	23
		239							243		

Juniors—Summer Work

	Number employed	No. returned later	Presently employed with BMCo. USA	Canada
1919–1931	116	39	9	1
1933–1942	—	—	—	—
1946–1951	5	4	3	—
Total, 33 yr	121	43	12	1

* Transferred with pulverized-coal and water-cooled furnace equipment activities to Fuller Lehigh in 1926 and 1927; then to The Babcock & Wilcox Company in 1931.

TABLE 3 ENGINEERING PERSONNEL AS OF OCTOBER 20, 1951

BAILEY METER COMPANY

	Department	Pre-cadet	Engrg grads who took cadet training course	Non-tech men who took cadet course	Engrg grads who did not take cadet course	Total engineers	Total in department	Percentage of engrs in dept
1	Officers	2	1	—	1	4	6	67
2	Branch offices	1	90	1	3	95	134	71
3	Sales, main office	—	21	—	—	21	31	68
4	Engineering, main office	—	19	3	—	22	54	41
5	Instructions, library, etc	—	1	—	—	1	10	10
6	Research	—	11	2	—	13	19	68
7	Design	—	3	—	4	7	55	13
8	Patent	—	2	—	—	2	3	67
9	Manufacturing	—	2	—	—	2	685	0.3
10	Production	—	1	—	—	1	62	2
11	Tool design, planning	—	1	—	2	3	20	15
12	Advertising	—	2	—	—	2	8	25
13	Education	—	2	—	—	2	3	67
14	Office staff — Acct., Purchasing, Steno, etc	—	—	—	—	—	155	0
15	1951 cadets in training	—	25	—	—	25	25	100
	Totals	3	181	6	10	200	1270	15 8

BAILEY METER COMPANY, LTD., CANADA

1	Officers	1
2	Branch offices	24
3	Sales, main office	3
4	Engineers, main office	4
5	Cadets in training	9
	Total engineers	41
	Total employees	101

and production departments. These departments are staffed mostly by young men and women from high schools, who enter suitable training courses conducted by the Company.

About 75 of the engineers presently employed have taken advanced work in universities and correspondence schools, including such subjects as business, chemistry, electricity, electronics, patent law, languages, metallurgy, public speaking, welding and foundry, salesmanship, and so on.

Further to promote this activity the Company repays one half of the tuition cost to the student upon his successful completion of the prescribed work for any course approved by the Company. Such courses must relate to the student's vocation or to humanities which promote better citizenship and human relations.

Engineering societies, such as The American Society of Mechanical Engineers, have great educational value. Each Company engineer pays his own dues in the engineering society of his choice. If he is requested to join a society for the benefit of the Company, it is the policy of the Company to pay the dues for all or part of such membership.

A recent poll shows that 67 per cent of all engineers of the Company are members of one or more societies; 38 per cent of all engineering employees of the Company are members of The American Society of Mechanical Engineers, 7 per cent are members of the American Institute of Electrical Engineers, 19 per cent members of the Instrument Society of America, 33 per cent members of local engineering societies, and 7 per cent members of six other chemical and engineering societies.

Many papers are presented each year to various societies and publications, and a number of the engineers are serving on society committees related to work within their spheres of interest.

INVENTIONS AND IMPROVEMENTS

The Company expends about 2.5 per cent of its gross income for education, research, and patent departments combined.

The spirit of improvement, invention, and progress is the business of everybody and is not restricted to the research department. Over the history of the Company and covering its present field of interest, 442 patents have been granted (or applications are pending) to 54 Company engineers. Eleven individuals are responsible for 325 of these patents, and the number of patents per individual in this group of eleven runs from 61 each for two persons down to 11.

COMPANY POLICIES

When the Company was started some policies were established and are still in effect:

1 Advancement in responsibility and pay is on the basis of individual merit as accurately as the management can evaluate it. Advancement on the basis of seniority does not prevail, except where other factors appear to be equal.

2 Increases in pay originate with the management, so that the individual need not be humiliated at any time by having to request an increase.

3 The engineering part of the organization is built up entirely from young engineering graduates. Older men from other companies are not brought into the organization over those entering as cadet engineers.

4 When any employee contacts customers or others, he has full authority to represent and speak for the Company, and his acts and decisions are supported by the management.

5 The products of the Company are to be useful and of the highest quality. New designs and products are developed only when there is none available from other sources which will meet the needs.

How well these goals have been accomplished only history and others can decide. Certainly the preparation of the data given herewith has been of benefit in uncovering some of the

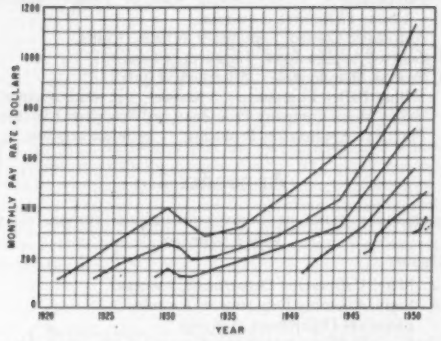

FIG. 2 ILLUSTRATIVE PATTERNS OF CHANGES IN COMPENSATION TO ENGINEERS

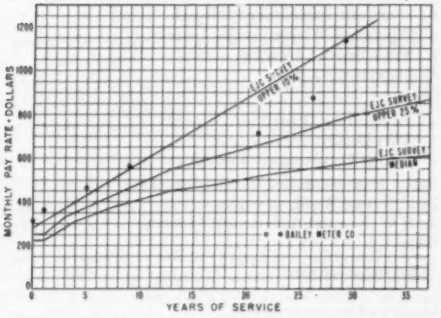

FIG. 3 COMPARISON OF RATE OF PAY TO BAILEY METER COMPANY ENGINEERS WITH DATA FOR MECHANICAL ENGINEERS
(From "Engineering Profession in Transition," Engineers Joint Council, 1947, p. 17.)

mistakes and shortcomings which previously had not been observed nor realized in the day-by-day activities of a busy life.

One important factor in this fast-changing world is the correct and fair adjustment of the individual employee's compensation. Fig. 2 shows the range of monthly compensation of several groups of engineers from the dates of their employment to the present time. A consistent rise during the optimistic period of the twenties, cutbacks during the early thirties, and a steady and inflationary rise since World War II will be noted.

Fig. 3 furnishes another basis for comparison. The full lines are from the E.J.C. survey[2] giving average rates of pay for mechanical engineers. It should be remembered that these data are from a 1946 survey, but they may be taken as representing the general pattern of pay for the median, upper 25 per cent, and upper 10 per cent, plotted against years of service. The points represent the current rates of pay for the Company engineers up to and including 5 years of service and 1950 rates for the others. In all cases the actual pay is given; some include overtime and others extra compensation above base rates. It is noted that above 20 years' service the engineering pay varies more than in the case of the younger men. The younger ones are advanced almost entirely by length of service, while later the compensation varies more with the openings available and the judgment of the management as to individual merit.

[2] "Engineering Profession in Transition," Engineers Joint Council, 1947, p. 17.

TRANSFER OF ENGINEERING CADETS TO OTHER INDUSTRIES

Table 2 shows that of the young engineering graduates employed by the Company about one half leave, mostly of their own choice. Fig. 4 shows a relatively lower rate of loss during 1920–1930 and from 1933–1941 than during the period 1931–1932, when unfortunately about 40 were laid off because of the then existing economic conditions, and during 1941 to date, when the general war conditions have constituted the primary cause.

An analysis of other losses can perhaps best be made by checking on the subsequent movements of the personnel involved. A certain percentage leave because they do not acclimate themselves to new surroundings; some because they do not like travel; and still others because they prefer to operate power plants and processes. Some take employment elsewhere at the solicitation of friends or relatives, or inherit a business.

The whereabouts of more than 90 per cent of the engineering graduates employed by the Company are known. The locations of 200 are listed in Table 4. Personal contact with a large number of these men from time to time has evidenced very good relations and co-operation on many matters of mutual interest.

TABLE 4 PRESENT OCCUPATION OF FORMER EMPLOYEES OF BAILEY METER COMPANY AND BAILEY METER COMPANY, LTD., CANADA, WHO TOOK CADET ENGINEERING COURSE

Field of work	Known number of men	
Education		12
Industry		
Automotive	5	
Aviation	6	
Cement	1	
Chemical	15	
Consulting engineering	16	
Electric power generating	16	
Equipment (various)	21	
Gas, manufacture	3	
Instruments and meters	4	
Manufacturers' representative	8	
Metals, nonferrous	4	
Paper, manufacture	12	
Petroleum	13	
Products, miscellaneous	27	
Railroad	3	
Steel	13	
Telephone and radio	4	
Total industry		171
Self-employed		1
Nonengineering		4
U. S. and Canadian defense		12
Grand total		200

The detailed duties are known with respect to 150 of these 200 former employees, and their status can be classified as follows:

Top executives, i.e., owner, partner, president, or vice-president, 11.

Upper management, i.e., chief engineer, production manager, manager, executive assistant, etc., 55.

Responsible position, i.e., mechanical engineer, design engineer, power engineer, sales engineer, supervisor, consultant. 76.

Manufacturers' representatives, 8.

COURSES FOR CUSTOMER ENGINEERS

The extent to which meters, instruments, and automatic control are used today in power plants and process industries requires one or more engineers to look after them; hence users

have developed departments to handle such work. In order that the men engaged in this work may become familiar with the details of such equipment and its servicing, they are invited to attend regular courses given by the Company.

General instrumentation courses were inaugurated in December, 1946. Since then the Company has conducted 30 classes of two weeks' duration. The total attendance has been 538 engineers from approximately 390 customer companies. Advanced courses have also been given to 49 engineers in four semiannual classes. Marine combustion-control courses have been given annually to 73 engineers in five classes.

CONCLUSION

While the preparation of this paper has entailed the compilation of many data and a study of problems which will be helpful in improving the Company's procedure, it is hoped that this presentation will help others to make better use of the most valuable asset our country possesses; namely, the potential skill, inventive genius, and engineering ability of American youth.

Appendix 1

CONDENSED OUTLINE OF 1951 CADET LECTURE COURSE, BAILEY METER COMPANY

1 Fundamentals and Theory of Flow Measurement; 7 lectures, 1 quiz.
2 Primary Elements for Fluid Flow; 6 lectures, 1 quiz.
3 Mechanically Operated Bailey Meters; 10 lectures, 2 quizzes.
4 Engineering and Sales Department Procedures; 5 lectures.
5 Principles of Combustion—Bailey Boiler Meter; 11 lectures, 1 quiz.
6 Major Steam-Generating Equipment; 5 lectures, 1 quiz.
7 Electronic Equipment; 18 lectures, 2 quizzes.
8 Fundamentals of Automatic Control—Bailey Control Units; 12 lectures, 2 quizzes.
9 Automatic Control Systems; 9 lectures, 1 quiz.
10 Control Applications; 7 lectures, 1 quiz.
11 Process Measurements; 5 lectures, 1 quiz.
12 Selling Bailey Equipment; 3 lectures, 5 practice sessions.
13 Bailey Meter Company Procedures and Practices; 5 lectures.
14 Practical Application Problems; 7 problem sessions.

Appendix 2

CONDENSED OUTLINE OF CADET ENGINEERING COURSE, BAILEY METER COMPANY

1 Factory
- *a* Meter Calibration Department, 9 weeks.
- *b* Light Assembly Department, 6 weeks.
- *c* Electrical Department, 3 weeks.
- *d* Research Department, 4 weeks.
- *e* Control Drive Department, 2 weeks.
- *f* Control Valve Department, 2 weeks.
- *g* Control System Adjustment and Trouble Shooting, 1 week.
- *h* Hydraulic Laboratory,[2] 2 weeks.
- *i* Piping and Wiring Panels, 3 weeks.
- *j* Stock Room,[2] 2 weeks.
- *k* Inspection,[2] 1 week.

2 Office
- *a* Engineering Department, 4 weeks.
- *b* Sales Department, 4 weeks.
- *c* Design Department,[2] 4 weeks.

3 Bailey Instrumentation Course, 1 week.
4 Field Service Work,[2] 4 weeks.
5 B. & W. Research Laboratory,[2] 1 week.
6 Clean Up

[2] Optional assignments.

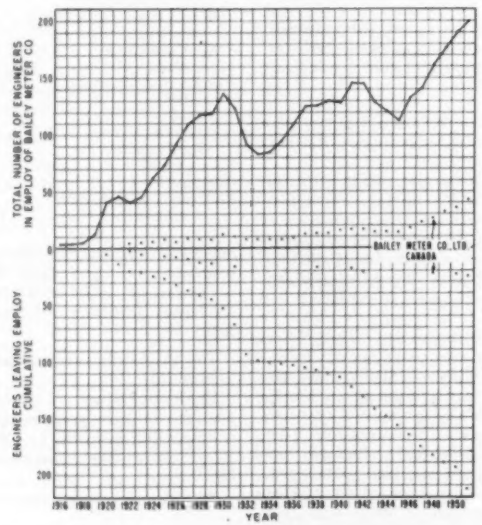

FIG. 4 HISTORY OF EMPLOYMENT AND SEPARATION OF ENGINEERING GRADUATES FOR BAILEY METER COMPANY AND BAILEY METER COMPANY, LTD., CANADA

LOW-LOAD OPERATION *of* SPREADER STOKERS[1]

IT has been established that the spreader stoker is a smoke producer especially at light loads. The panel discussion which follows develops the various features of the present-day stoker which can be applied to produce smokeless operation during low-load periods. Each of these features has its particular field of application depending upon local load and plant conditions.

Operating Spreader Stokers at Light Loads

By F. C. MESSAROS

CHIEF ENGINEER, AMERICAN ENGINEERING COMPANY, PHILADELPHIA, PA. MEMBER ASME

MOST automatic coal burning is carried out by one of three methods. Each type of firing has its special appeal. They may be generally classified as follows:

Class 1, crushed coal burned on grates.

Class 2, finely divided coal burned in suspension.

Class 3, crushed coal burned partly in suspension and partly on grates.

Class 1 is usually a traveling metal belt with coal fed to it from a hopper, or an underfeed stoker. Both types properly engineered give freedom from fly ash and smoke, although the range of coal that can be burned on the traveling grate is somewhat limited and is more sluggish in responding to load variations.

Class 2, finely divided coal, now dominates the large-boiler field, i.e., over 300,000 lb of steam per hr. With this system, excellent results have been obtained, but stack discharge is a serious problem requiring very expensive dust-collection systems. When trapped the fly ash is troublesome to handle and usually costly to discard. Auxiliary power costs also are high.

Class 3, spreader stokers lie somewhere between the other two systems. It is a generally accepted fact that they are the most versatile in handling a wide range of coals. They require little power to operate and are very responsive to load changes. They lie between classes 1 and 2 in stack discharge, and greater care must be exercised in design and operation to insure satisfactory operation in so far as smoke is concerned, particularly at the lower ratings.

While old in conception, spreader firing has been widely accepted only recently. A few years ago a spreader-fired unit of 100,000 lb per hr capacity was rare, yet today 200,000 to 300,000 lb per hr are established, and much larger units are under discussion. Of course there are problems to be solved but with the increasing and intense interest exhibited by leading combustion authorities in this type of equipment, rapid progress is being made in this field.

[1] Panel contributed by the Fuels Division and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

SOME SPREADER-STOKER PROBLEMS

Several problems in spreader-stoker firing require additional attention, namely, excess air at low burning rates and smoke.

Not infrequently the buyer will specify higher peak capacities than are really required which result in excessively low burning rates at the minimum required steaming rates. This exaggeration of the real requirements has led some stoker manufacturers to gamble on the real load required and offer too little grate area for the specified peak. If they guess right, the problems such as smoke at low steaming rates are minimized, but if the peak specified happens to be correct, excessive burning rates may result.

Adequate furnace volume is extremely important with spreader stokers. In many instances it is found impractical to apply spreader stokers to existing boilers because of this limitation. Where this important consideration is ignored, it may be impossible to compensate for this deficiency by increasing the amount of overfire air to secure greater turbulence.

Also, the question of type of load has a direct bearing on furnace design. The author can illustrate this best by two installations of a well-known stoker manufacturer.

Case 1: 180,000 lb per hr specified continuous day and night, 7 days per week on a rebuilding job with more steam desired, if possible, but with no load below 130,000 lb per hr anticipated.

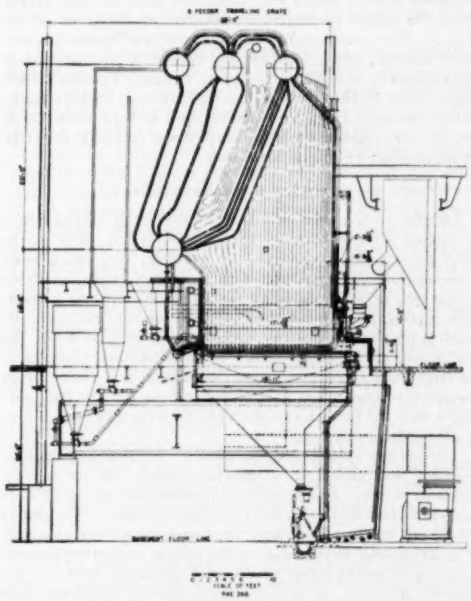

FIG. 1 GENERAL ARRANGEMENT OF 200,000-LB PER HR SPREADER-STOKER INSTALLATION

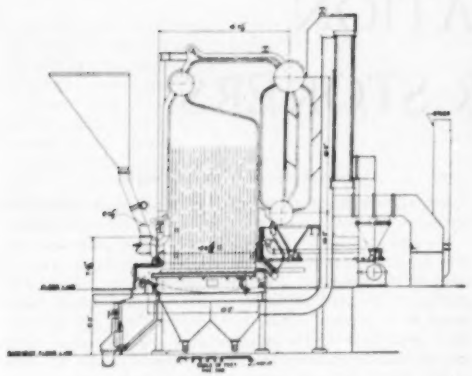

FIG. 2 INSTALLATION FOR 60,000 LB PER HR MAXIMUM AND 15,000 LB PER HR LOW-LOAD OPERATION

Fig. 1 shows a general arrangement of the installation. Freedom from low ratings permitted the maximum use of cold surfaces, so the rear and side walls were completely water-cooled right down to the stoker level. Actual operation justified the extra attention given to the furnace, and capacities of 200,000 lb instead of the 180,000 lb per hr were found practicable with burning rates as high as 800,000 Btu per sq ft per hr.

The same manufacturer selected three boilers for a second plant where a wide variation in load was anticipated. His engineers studied future load conditions and, in consultation with the stoker manufacturer, selected the units shown in Fig. 2. Here water-cooling the rear, side, and front walls was more limited, and refractory was carried up the front wall approximately 4 ft above the grate to control smoke which might occur at that point at low burning rates with excessive water cooling. Here the steaming rates as high as 60,000 lb per hr were possible with low loads down to 15,000 lb per hr with satisfactory smoke conditions.

APPLICATION OF OVERFIRE AIR

Overfire air is a must with spreader stokers to control smoke at higher rates of burning, but becomes of less value as the unit burning rate decreases. For example, very small units may operate satisfactorily with refractory walls, without direct overfire air if the fuel distribution on the grate is good. The setting leakage provides sufficient overfire air with the high-temperature refractory walls helping ignition while the propelling air for cinder return provides adequate turbulence. In large units all overfire air may be shut off at the low ratings except that required at the feeders to float out the finer particles into the furnace and with the cinder-return system providing some overfire air.

Uneven coal spread produces smoke. A consulting engineer recently was called in to eliminate smoke on an existing spreader stoker. He recommended overfire air jets, which were installed, and these afforded little improvement. The smoke could not be cleared up until even coal spread was obtained. The importance of even coal spread cannot be overemphasized. The use of paddle-wheel rotors with adjustable blades is frequently at fault. If set correctly originally, they may shift their positions or when worn and replaced are usually not set properly. Rotor speed also should be adjusted to establish the proper trajectory with coal of a given consist and should be corrected if this consist varies to include a greater or lesser amount of fines. Unless attention is given to these important features of spreader-stoker operation, the desired objective of an even coal spread will not be attained. In their constant study of this problem, the author's company has found it necessary to maintain a life-size laboratory model which permits a check of the spreading characteristics of different fuels with the grate area adjustable to permit checks on variations in proportion to lengths and widths of areas fed by each feeder. Our British licensees, operating quite independently, have found the same sort of laboratory setup essential, but with typical British independence call their work "bench tests."

UNEVEN COAL DISCHARGE FROM FEEDERS

Another extremely important factor leading to smoke on spreader installations is uneven discharge of coal from the feeders, in other words, feeding slugs of coal. Experiments were conducted where uneven or slug feeding was accomplished deliberately and a smoky stack resulted. This was particularly true at low ratings and with coals high in surface moisture. Good judgment, therefore, dictates the selection of a feeder design which feeds coal continuously and evenly onto the rotor. Fig. 3 shows a feeder which meets these requirements. It will be noted that the coal is discharged onto the rotor by means of a continually moving scraper chain. Also it will be noted that the adjustable throat controls the amount of coal discharged and, by virtue of its position, the coal from the hopper cannot avalanche onto the rotor in slugs.

Excess air at all ratings justifies more attention. Many spreader-stoker installations today bristle with overfire air and cinder-return nozzles like the cannon on old wooden "ships of the line," and all of these nozzles pump air into the furnace—much of it of little value in producing turbulence and actually quite detrimental to performance.

Part of this is caused by the large number of drain points from which cinders must be conveyed to the furnace. Better design and arrangement of the boiler, economizer, preheater, and dust collector can help this. For example, in several instances the dust accumulating in the dust collector was drained into the last pass of the boiler thereby eliminating cinder-return nozzles, Fig. 4. This is not practicable in a heavy-duty installation where the dust loading of the conveying air would be excessive, but should find frequent use in the average moderate-duty installation.

There always has been the question of the merits of returning

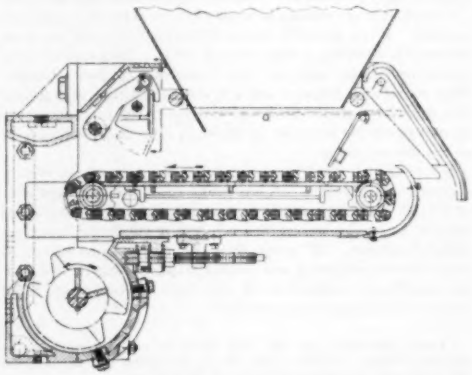

FIG. 3 DESIGN FOR FEEDING COAL CONTINUOUSLY AND EVENLY

the fly ash to furnace at low loads. If proper analysis is given to the problem on each job, it very often is found that return of this material is not worth while. In other words, it would seem that the fly-ash return equipment should be arranged to cut out the return when on low loads for extended periods. The amount of carbon lost in the wasted fly ash at such loads is usually counterbalanced by the improvement in CO_2 because of the omission of the fly-ash propelling air.

Recent trends indicate an increase in the number of installations using a decantation type of dust collector in which only the coarser particles, high in carbon content, are reinjected and the finer particles rejected. This tends to reduce dust loading and simplifies the reinjection process. In some installations the dust collector is installed ahead of the economizer or preheater thereby reducing the number of drain points required and also protecting the economizer from the scouring action of the cinders.

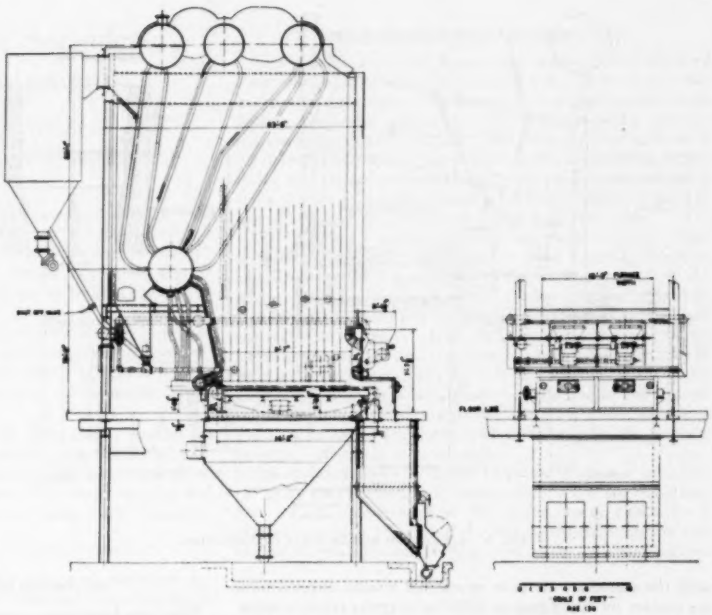

FIG. 4 ARRANGEMENT FOR ELIMINATING CINDER-RETURN NOZZLES

Too little attention has been paid to the tightness of settings and between the edges of grate surface and furnace walls. Obviously, this cannot but contribute to low CO_2, and the same care should be exercised with respect to this problem as is customary with every design of furnace.

Also, it might be well to mention that the draft over the fire should be hand-adjusted to practically zero when on low loads for extended periods. This will help to maintain a higher CO_2 as less air will be drawn through the setting walls. Of course, with an exceptionally tight setting, the procedure may be of slight benefit.

One progressive engineer has utilized small quantities of extra-high-pressure air to produce satisfactory turbulence. This raises the CO_2 in the furnace, or alternatively will permit the use of coal with lower ash-fusing temperatures with the same CO_2, since the overfire air saved may be passed through the fuel on the grate to lower the temperature of the fuel bed.

AIR-CONTROL SCHEMES

For some reason, otherwise good engineers, but with limited experience in the coal-burning field, are attracted by the idea of air zoning to permit a certain portion of the grate to be shut off or receive a throttled air supply with adjustments of the air supply made by the operator at will. It all appears so logical—just direct the air through the active portion of the fuel bed, and blank off the inactive portion of the grate.

Fixed zoning under grates is as old as the hills and in some cases is most effective. Zoning under the traveling- or chain-grate stoker apparently is a necessity and is perhaps justified by the fact that all the fuel is committed to the grate at the front wall, and nothing further can be done to correct bad spots in the fuel bed.

On the other hand, literally hundreds of air-control dampers have been removed. The cold hard facts are that few men are capable or willing to distribute the coal properly that they can see and air that they cannot see. Stoker grates have been divided into checkerboard sections, each equipped with an air-metering device, and it has been proved that a stoker operator cannot keep the flow of air even approximately equal through each checkerboard when he depends upon observation. Fig. 5 shows an operating panel installed on several stoker installations in a major utility station. Each button regulates a damper in the checkerboard grate. When any particular section on the fuel bed needs more or less air, the corresponding button on the panel is manipulated by the operator. While a novelty to the boiler operators at first, it later proved a nuisance and troublesome and eventually it was discarded. Frequent checks on adjustable zoning dampers show that practically all become inoperative or are removed after a few years of service.

On the continuous-ash-discharge spreader stoker, the fuel is being continuously supplied to all areas of the grate. Consequently, there should be no need for zoning control providing fuel distribution is good. Therefore it is believed that zoning dampers tend to complicate the work of the operator and should be avoided on traveling-grate spreader stokers.

HIGH-TEMPERATURE OVERFIRE AIR

Another item worth mentioning is the use of high-temperature overfire air to improve combustion and to reduce combustible in the carry-over. Experiments were conducted on a small boiler with refractory setting fired by a dump-grate spreader stoker. The original design consisted of solid refractory walls

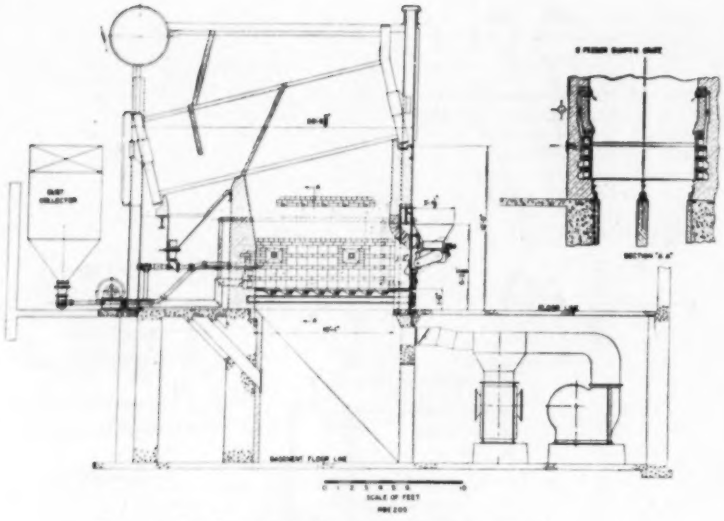

FIG. 6 AIR-COOLED BOILER-WALL INSTALLATION

with the customary series of overfire-air nozzles directed into the furnace for turbulence in addition to cinder-return nozzles from the boiler passes and the dust collector. Combustible in the fly-ash collector hoppers averaged 50 per cent. The need for increased capacity dictated the installation of air-cooled walls, and these were later installed as shown in Fig. 6. Here the air was pumped through the hollow refractory walls thereby raising the air temperature to approximately 1000 F and then discharging it into the furnace. This method of preheating the overfire air not only improved combustion (CO_2) but analysis of the fly ash from the collector showed a remarkable reduction in combustible from 50 to 5 per cent. Because of this reduction in the carbon content of the fly ash and difficulties encountered in ash build-up on walls, it was decided to discontinue its reinjection, and since then the material has been discharged to the ash silo. While this is only one case, it does seem to indicate that further experimentation on spreaders with smaller than usual quantities of overfire air but of extra-high pressures and temperatures is warranted.

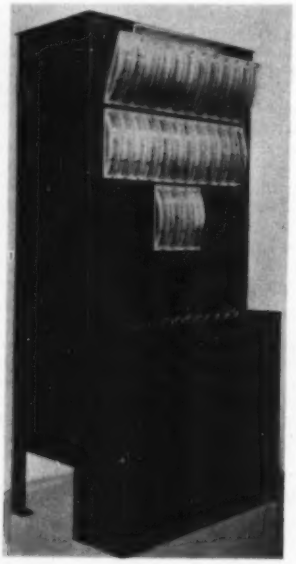

FIG. 5 DAMPER-OPERATING PANEL

LOCATION OF OVERFIRE-AIR NOZZLES

There has been much controversy regarding the proper location of overfire-air nozzles above the grate. Present opinion seems to indicate that their best position should be close to the grate. This is plausible since smoke generally is formed very close to the fuel bed as well as in the region of the feeders. One user decided to play safe on this question and installed a line of nozzles at two different levels as shown in Fig. 1. Actual results indicated a satisfactory stack whether upper or lower rows were turned on and no noticeable difference was apparent in smoke readings. Of course this does not mean that overfire-air nozzles may be placed at any height, but merely illustrates one case where the nozzles set 7 ft (upper row) above the grate did not affect operation from the aspect of smoking. As a matter of fact, on the succeeding four units, now under construction by this customer, the upper row of nozzles is being omitted. It will be noted that the lower row which will remain is set about on the center line of feeder opening but with the nozzle tipped toward the grate. In the author's opinion, the nozzles should be placed even closer to the grate than the lower row shown in Fig. 1, but design factors such as the clearing of furnace doors, structurals, waterwall headers, and so forth, often determine how low the nozzles may be placed.

CONCLUSION

None of the operating problems in spreader-stoker firing mentioned is insurmountable. They may be avoided by proper design and close adherence to the manufacturer's operating instructions. With any mechanical device in the combustion field, the human element is often to blame for poor operating results, assuming, of course, that the installation was designed properly in the first place. In such cases the best remedy is to employ one of the stoker manufacturer's operating engineers to check plant procedure and, through a refresher course, correct bad practices of operating personnel. Such an investment will be found to pay dividends in increased efficiency and decreased maintenance.

How to Select Spreader-Stoker Equipment

By MAX O. FUNK

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MEMBER ASME

THE spreader stoker is adaptable to operation through wide load ranges, but at extremely low points a smoke problem generally appears. To be more specific, it has been our experience that furnace temperatures at the fire line below a grate heat release of 120,000 Btu per sq ft per hr become too low to avoid smoke with most coals.

A parallel problem, which also affects the first, is one of high excess air which is difficult to avoid at extremely low heat releases. The high excess air tends further to reduce furnace temperatures at the fire line and also to contribute to the smoke difficulty.

Therefore the whole problem of light-load operation of spreaders resolves into one of maintaining reasonable minimum grate-heat releases for adequate temperatures and excess air at the grate line. It can be considered from three separate and distinct viewpoints, namely, selection, design, and operation.

SELECTION OF SPREADER-STOKER EQUIPMENT

In the selection of spreader-stoker equipment for steam demands which will include low-load conditions, a realistic maximum load condition must be chosen so that an excessive range of operation will not penalize low-load operation. Since the stoker must be sized for maximum continuous conditions and acceptable minimums are a function of the maximums, any oversizing of equipment is reflected in higher acceptable minimum conditions. For a given range of steam demand it may be necessary to use more units of a smaller size to achieve maximum requirements while at the same time staying in an acceptable range for minimum requirements.

It is possible to increase the range of stoker operation to some extent by increasing the grate heat releases at maximum, but a gain of one increment at low load is achieved only by an increase of five or more equal increments at high load, depending upon the range of operation involved. This avenue of solution is limited by the degree of compromise which can be tolerated in high-load operation before carbon losses and reduced efficiencies become prohibitive.

Some factors in stoker design have a pronounced effect on low-load operation. Continuity of coal feed to eliminate a cycling grate heat release is one. Control of air and coal distribution so that given grate areas can be reduced during low-load periods is another. Overfire jet arrangement, especially with regard to elevation of above the grate, is a third and very important one.

Furnace arrangement has no great effect. Water-cooled walls have been covered with refractory and uncovered again with no marked change in low-load operation, because the wall cooling has little effect in the critical area immediately above the grate.

All of the practices which make for good stoker operation at any rating are even more important at low loads. Good coal and air distribution, coal-air ratios for lowest possible excess air, and continuity of coal flow are especially important. Where wide load ranges are involved, up to 8 or 9 to 1, it is often desirable to use complete manual control through the low range to maintain stable fire conditions, even at the expense of close pressure regulation. This regulation is not generally critical at low loads.

TYPICAL SPREADER-FIRED STEAM GENERATOR

It is possible to select, design, and operate a spreader-fired steam generator for wide load ranges. Fig. 1 shows a unit that has operated through a 9 to 1 range. It includes a two-drum boiler, superheater, economizer, dust collector, and a continuous-discharge spreader stoker. This unit was designed for a maximum of 92,500 lb of steam per hr and a minimum of 10,000 lb per hr. It can perform through this range and maintain a stack discharge which remains within the limits of a local smoke ordnance similar to the ASME Suggested Code.

Fig. 2 shows a similar stoker arrangement in larger scale. Several features which contribute to good low-load performance are included. In addition to the air jets located in the rear wall at an elevation of about 3 ft above the grates for normal operation, steam jets are located at 9 in. above the rear of the stoker and at 12 in. above the front of the stoker. Air or steam can be used at these locations, but in this case steam could be more conveniently installed. With extremely short flame length at low loads it was found that the smoke was formed before the jets located 3 ft above the grate could have any effect. The lower jets introduced turbulence in the burning areas and effectively reduced smoke.

Fig. 3 shows how the ability to reduce grate-area increases the grate heat released to an acceptable level at the minimum load. Each compartment of the stoker can be closed by a damper located at one side of the stoker, and the length of the fire can be reduced by one speed control on the feeder-unit drive.

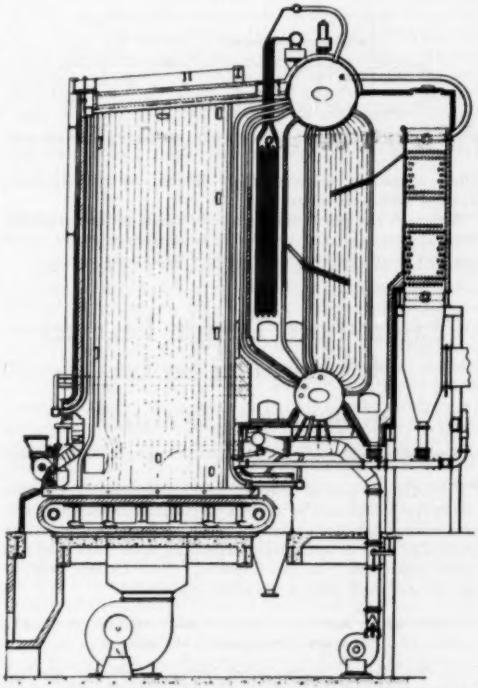

FIG. 1 SPREADER-FIRED STEAM GENERATOR DESIGNED FOR 92,500 LB PER HR MAXIMUM AND 10,000 LB PER HR MINIMUM

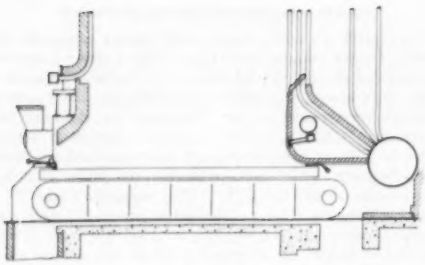

FIG. 2 DETAIL OF SPREADER-STOKER ARRANGEMENT

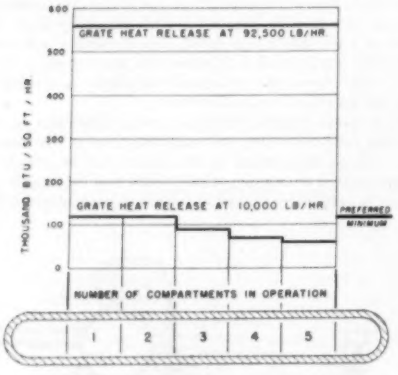

FIG. 3 EFFECT OF REDUCING GRATE AREA ON GRATE HEAT RELEASE

These operations are more than justified by the resultant doubled grate heat release.

Although the principles discussed have been illustrated by their application to a continuous ash-discharge stoker, they can also be applied to stokers of the dumping-grate type.

Light-Load Design Features for Spreader Stokers

By HERBERT L. WAGNER

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THERE are several features of the present-day spreader stoker which can be applied to produce smokeless operation during light-load periods. Each of these features has its particular field of application depending upon local load and plant conditions. In the following these features will be enumerated, and their application explained.

BURNING RATE—POUNDS OF COAL OR HEAT RELEASE IN BTU PER SQUARE FOOT OF GRATE PER HOUR

In this day of water-cooled furnaces from the smallest package boiler up to the larger installations, the designer no longer can expect to consume the smoke and volatile gases by reflected or radiated heat from refractory walls and arches. On the average job, the water cooling of the furnace walls is a dire necessity at the higher-load brackets. This is especially true when the constant trend toward coal of lower quality is considered and correspondingly lower ash-fusion temperatures. Therefore the floor of the furnace, namely, the grate and the area immediately above the grate, is the only place where this so-called smoke-consuming work can be performed. Hence it is necessary that the lowest expected load and its respective burning rate receive just as much consideration as the maximum load and its corresponding burning rate. Each designer knows or should know the danger line on low burning rates beyond which it is not safe to go. The maximum burning rate should be established in keeping with the type of grate in question, namely, the continuous cleaning versus the intermittently cleaned, the size and shape of the furnace, the amount of water cooling in the furnace, and the fuel to be burned.

Intermittently Cleaned Grate. On this type of grate a heat release of 350,000 to 600,000 Btu per sq ft per hr, depending upon the amount of ash in the fuel, is practical. On high-ash coals it is often necessary to reduce the time between cleaning periods. This increases the spread between possible minimum and maximum burning rates thereby increasing the spread between the low- and the high-load range. The number of feeders per stoker plays an important role in this phase of grate selection. (This will be covered later in the paper.)

The time required and the method used for cleaning the ash pit also must be considered when the size of the grate is selected.

Continuous-Cleaning Grate. Little consideration need be given to the amount of ash in the fuel, providing the volatile content is not too low. It has been found by field experience gathered from many installations that a heat release of from 700,000 to 800,000 Btu per sq ft of grate per hr is practical. Units have now been in operation for approximately 10 years, burning fuels of the following spread in analysis: Ash content 25 to 4 per cent, Btu 7000 to 13,500 per lb as fired. This spread in fuel quality was handled by the same units under the same load conditions, with no apparent sacrifice in the maximum steaming capacity.

The spread between the maximum and the safe minimum burning rate establishes the safe spread in load that can be carried successfully. A load ratio of 3 or 4 to 1 on dumping grates and 6 to 1 on continuous-cleaning grates can be handled easily, providing the stoker is properly fitted to the load.

NUMBER OF FEEDERS TO BE INSTALLED ON AN INTERMITTENTLY CLEANED GRATE

The number of feeders installed on an intermittent-type grate is important and plays a large part in the successful performance of the unit. On this type of stoker quite frequently the percentage of ash in the fuel will dictate the number of feeders to be used, and often it is found necessary to use three feeders where two might do, or four feeders where three might do. Installing more feeders naturally facilitates better cleaning conditions, provides for more adequate load-carrying capacity during cleaning periods, as well as for a better ratio between feeding width and grate width, which in turn greatly enhances the fuel distribution crosswise of the grate. This also reduces the tendency toward fishtail fires and all the problems that go with them. This is also important on jobs where a wide swing in load is to be handled because fuel distribution is of much greater concern at the lighter loads, since the air pressure under the grate is likewise low. Therefore the maldistribution of the fuel on the grate, caused by an insufficient number of feeders, will immediately show up in the formation of pancake clinkers and a smoky furnace condition.

On many installations, depending on the shape of the furnace and the path of the flame travel from the grate to the furnace exit, extreme light loads can be carried on a portion of the feeders installed on the unit. However, this is not a cure-all because it does not work equally well on all jobs.

PATTERN OF OVERFIRE-AIR AND CINDER-RETURN SYSTEM TO CREATE FURNACE TURBULENCE

The pattern of the overfire-air system is of great importance and, in general, must be designed to suit the shape of the furnace and the length of flame travel, the path of the gas travel from the grate to the furnace exit, and the expected range in load to be carried. Where the turndown ratio in load is exceptionally severe, it is necessary to supplement the high-pressure overfire-air system with steam jets. In this case the steam jets are used for the extremely light-load conditions only, while the high-pressure air system is used for the medium- and heavy-load conditions. This is easily understood when it is considered that during these extreme light-load conditions, the furnace is quite well loaded with excess air due to infiltration, low burning rates, and so forth. Furthermore, the furnace temperature is likewise very low. Therefore, by using high-pressure air as a medium for creating furnace turbulence under these low-load conditions, more excess air is added to the furnace and the furnace temperature is chilled still further.

By using steam jets as a medium for creating furnace turbulence under extremely light loads, naturally the excess air that already is in the furnace is put to work and the chilling or cooling of the furnace is greatly reduced. The steam jets could of course be used over the entire load range, but they are expensive to operate and maintain and, as a rule, high-pressure air jets of proper design will cover more completely a larger furnace area causing the volatile gases and the air to intermingle more fully with less tendency to blow through, leaving undisturbed areas at each side of the jet.

The elevation at which the cinder returns enter the furnace and their lateral spacing likewise are of great importance. Since the cinders consist mostly of coke breeze with a high percentage of ash, they must be injected into a high-temperature zone to expedite ignition of the small particles of coke and carbon. Also the lateral spacing of the return lines is quite critical in order to maintain uniform distribution with the absence of piling on the grate.

Air at pressures of from 10 to 30 in. of water has been found to be the most satisfactory and practical means of conveying the cinders back to the furnace.

LONGITUDINAL ZONING OF GRATE ON A CONTINUOUS-ASH-DISCHARGE SPREADER STOKER

On intermittently cleaned spreader-type stokers, each feeder should have its respective grate section with dumping mechanism and individual plenum chamber and ash pit or bunker. This is of utmost importance in order to retain complete control of the grate sections and their respective feeders that are in service, as well as those that are being cleaned.

Longitudinal zoning on continuous-cleaning-type spreader stokers is one of the several means of coping with light-load conditions. This feature also lends itself very well in case of mechanical failure of part of the grate or drive mechanism. Occasions have been reported where 70 to 90 per cent of the total load has been carried on one half of the grate while the difficulty on the other half was being repaired.

Where longitudinal zoning is employed for light-load conditions, the overfire-air and underfire-air system likewise must be divided at the common division lines so the air can be shut off on the idle side. By the use of this system with one half of the grate in service, the burning rate for a given load is doubled with a correspondingly higher temperature in the fuel-bed zone of the furnace. The fire is likewise brisker, with higher air pressure under the grate, thereby reducing the tendency of the fuel and ash bed to pancake or form skin clinkers.

LATERAL ZONING OF REAR PORTION OF CONTINUOUS-CLEANING SPREADER STOKER

On units where the expected turndown ratio in load is in the bracket of from 6 to 1 to 12 to 1, the foregoing arrangement lends itself very well. A predetermined section of the grate at the rear end of the furnace is zoned off so that the air can be shut off completely. At the same time, the fuel trajectory is lowered so that the incoming fuel is spread only over that portion of the grate which is air-supplied. This is another method of reducing the effective air-supplied coal-burning area of the grate. This immediately increases the burning rate per square foot of grate with a correspondingly higher furnace temperature in the fuel-bed zone of the furnace. By reducing the effective air-supplied coal-burning area of the grate and thereby increasing the burning rate per square foot, a more efficient fire is produced. This makes it possible to reduce the amount of excess air in the furnace and also clean up the stack gases in keeping with present-day ordinances. Units are in operation where a turndown ratio of 10 to 1 is handled quite comfortably.

By knowing the expected load range or turn-down ratio and by selecting the grate so as to give the proper heat release per square foot of grate at the maximum rating and further utilizing the lateral zoning feature, it is easily possible to design a continuous-cleaning spreader-stoker installation to handle load ranges of 12 to 1 and better. A smoke density in the neighborhood of Ringlemann No. 1 or less can be maintained over the entire load range. This, however, cannot be done if the top limit of the burning rate is established at 500,000 Btu per sq ft of grate.

COKING ZONE AT REAR END OF CONTINUOUS-CLEANING SPREADER STOKER

This scheme of smoke control on continuous-cleaning spreader stokers has been developed on five different installations. Two different lines of attack were employed to obtain the same end result. The main objective in this scheme is to shut off the air for a certain portion at the rear end of the grate. The trajectory of the fuel feed is set so as to spread the fuel up to the front face of the bridge wall. The fuel that lodges on this portion of the grate is given time to coke and drive off some of the volatile matter. It naturally becomes sticky in going through this process and the finer particles are conglomerated with the larger particles. As the grate continuously moves forward, the coking fuel eventually is moved out over the air-supplied area of the plenum chamber. As the grate is moving forward, the fuel bed is given a chance to increase in thickness to a point where, when it reaches the air-supplied portion of the plenum chamber, there is less tendency for the air to blow the fine fuel particles off the grate, thereby greatly reducing the carry-over of fly ash and fly carbon. Likewise, it materially reduces the excess air in the furnace at the rear end of the grate and it has been found possible to operate with lower excess air than had heretofore been thought possible, with this type of fuel-burning equipment.

Excess air of 15 to 18 per cent in the furnace is practical and can be maintained over an exceptionally wide range in load.

Also it has been found that even with this low percentage of excess air, the smoke density is surprisingly low. Smoke densities of No. 1 Ringlemann or less can be maintained easily.

SIZE CONSIST OF FUEL

The size consist of the fuel plays an important part in the successful and smokeless operation of a spreader stoker. Some have earmarked this type of fuel-burning equipment as a device that would burn anything. This is not necessarily true. Fuel segregation is bad for any stoker and this is likewise true for a spreader stoker. Since a part of the fuel is burned in suspension, segregation causing all nut coal on one side of the furnace and all fines on the opposite side, will upset furnace conditions seriously. The side of the grate receiving the nut coal will develop a deep fuel bed with correspondingly high fuel-bed temperature. This in turn will cause clinkers and smoke.

The ideal fuel size for a spreader stoker is $^3/_4$ in. × 0 in. with one third $^3/_4$ in. × $^1/_2$ in., one third $^1/_2$ in. × $^1/_4$ in. and one third $^1/_4$ in. × 0 in.

Where coal segregation is present it will be less pronounced with the finer-sized fuels. Nut, pea, and slack of $1^1/_2$ in. × 0 in. or 2 in. × 0 in. should not be used on a spreader stoker if the best results are to be expected. This is especially true for high-ash coals or any coal at light-load conditions.

CONCLUSION

In the foregoing discussion an attempt has been made to outline the different phases to be considered in the proper selection of a spreader stoker. Further, it has been attempted to show that the stoker with the proper arrangements can be selected which will handle a wide range in loads satisfactorily. The minimum and maximum load to be carried must receive equal consideration. The overfire-air and cinder-return systems must be tailor-made, designed for the job in question. The type of zoning and the number of feeders also are very critical and must be selected to fit in best with the load, coal, and plant conditions.

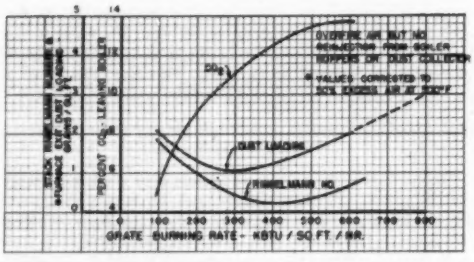
OVERFIRE AIR, BUT NO REINJECTION FROM BOILER HOPPERS OR DUST COLLECTOR
CO2
DUST LOADING
RINGELMANN NO.
GRATE BURNING RATE - KBTU / SQ FT / HR

FIG. 1 LOW-LOAD PERFORMANCE OF SPREADER STOKERS

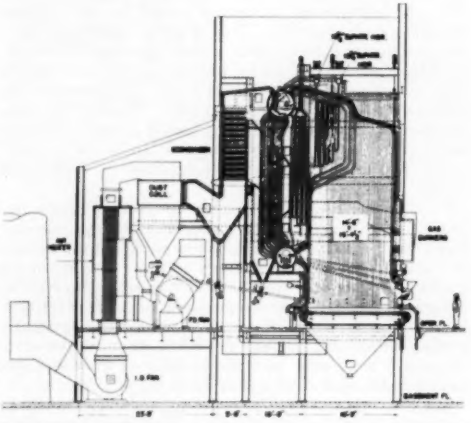

FIG. 2 FRONT-DISCHARGE TRAVELING-GRATE SPREADER STOKER

Practical Suggestion on Low-Load Operation of Spreader Stokers

By EARLE C. MILLER

RESEARCH ENGINEER, RILEY STOKER CORPORATION, WORCESTER, MASS. MEMBER ASME

THE performance of spreader stokers at low loads is the most serious handicap in this type of firing. Smoke and high excess air at low loads are the two most common complaints of modern spreader-stoker installations. While it is true that refractory furnaces and special coals can eliminate smoke, it must be assumed that the modern steam-generating units will have water-cooled furnaces and will be fired by the most economical fuel. The problem is one of improving the spreader stoker to overcome the weakness of smoke and high excess air, rather than the use of refractory furnaces and special fuel to overcome these difficulties.

Data have been taken from a recent ASME paper[1] to illustrate the low-load performance common to many spreader-stoker installations. These data, Fig. 1, were selected because the controversial question of reinjection had been eliminated. There is common agreement that a weakness exists, and there most of the agreement stops. The author believes that the low-load difficulties can arise from many causes and, frequently, the causes are multiple. Coal characteristics, distribution of coal and air, uniformity of size of coal or segregation, combustion-control action, grate burning rates, furnace turbulence, and furnace temperature affect smoke, and certainly all are related to the excess air. In addition to these points the stoker design may be a contributing cause.

COAL CHARACTERISTICS

The tendency of some coals to smoke when burned on spreaders is not only a function of the volatile content, but also of the burning characteristics. Frequently, it has been observed that high-volatile coals from one field will burn smokelessly at low loads, while coals of similar analyses from other fields will smoke when burned in the same unit.

A completely water-cooled unit of the type shown in Fig. 2, has operated on automatic control down to 40,500 Btu per sq ft of grate per hr without smoke, and has maintained this rating for days; however a duplicate unit developed smoke at 112,000 Btu per sq ft of grate per hr. The differences between coals will have to be accepted, and improvements in equipment made, to meet the requirements of the smoking coals.

[1] "Methods of Reducing Dust Emission From a Spreader-Stoker-Fired Boiler Furnace," by W. C. Holton and R. D. Engdahl, Trans. ASME, vol. 74, 1952, pp. 207–218.

DISTRIBUTION OF COAL AND AIR

Generally, distribution of coal and air by the spreader and grate is accomplished satisfactorily. Ease of adjustment varies in individual designs, but the attention of the operator is required to compensate for changes in moisture and size of fuel. Lacking distribution, both smoke and high excess air result.

UNIFORMITY OF SIZE OF COAL

The uniformity of the size of coal reaching the stoker is an important factor in the performance of any load, but is critical at the low end of the operating range. Segregation of sizes between feeders makes securing uniform distribution all but impossible. Frequent variation in size of fuel also aggravates distribution even though no segregation is present. In respect to uniformity of size and segregation, the spreader stoker is less affected than other types of stokers, except at low load.

COMBUSTION CONTROLS

It is sometimes observed that low-load smoke is reduced, and occasionally eliminated, by retarding the action of the combustion controls or by controlling manually at low loads. At low ratings the process of combustion is much slower than at high ratings, therefore, if the air and fuel rates are increased too rapidly the air passes on before the coal burns, thus leaving an excess of coal on the grate. While the excess coal is burning, smoke is usually formed. This is noticed most often when the load is increased suddenly from low load, or on a fluctuating low load. In the latter case, periodic puffs of smoke can be observed.

FURNACE TEMPERATURE

Having considered the foregoing it becomes obvious that further improvement must come through the stoker and its accessories. The design of the turbulence system, design of furnace, and the selection of stoker burning rates, combine to produce the conditions which will contribute to smoke or, conversely, may combine to minimize smoke. The common denominator for all of these factors is the temperature existing in the burning zone. It has been common practice in all types of stokers to guard against low-load smoke by maintaining a favorable ratio between the refractory surface and the water-cooled surfaces of the furnace envelope. The resultant penalty of furnace care and maintenance has been tolerated. An increase in water cooling is the aim of furnace designers, and this advancement should not be blocked. The design of overfire-air system, use of preheated air, and control of grate burning rates, can be combined to offset the effect of waterwalls.

PREHEATING OF AIR

Preheated air has a greater influence on low-load burning than is apparent from its effect upon the average furnace temperature. Limited data indicate that, with other factors constant, 300 F air temperature can reduce the low-load smoke point from approximately 110,000 Btu per sq ft grate to less than 50,000 Btu per sq ft of grate. Resistance to the use of preheated air for stokers reflects a fear of lubrication difficulties or grate maintenance. Neither is a valid reason for eliminating preheated air. The grate maintenance of the spreader stoker is seldom high enough to warrant consideration. Traveling-grate stokers have operated with preheat in excess of 400 F for many years without lubrication difficulties.

FURNACE TURBULENCE

Furnace turbulence is an essential part of spreader-stoker firing and is provided in the form of steam or air nozzles. Steam nozzles represent the lowest initial cost but owing to the high operating costs are seldom used. Air-turbulence systems are designed to obtain penetration by balancing nozzle size and static pressure. Papers on the basic design factors of furnace turbulence and performance of overfire-air systems are available.[1,2] The source of the air, rather than the details of design and location of nozzles, will be considered here.

The quantity of overfire air varies but common practice is 5 to 10 per cent of the total air at maximum load. Since the need for turbulence at low load is great, the total quantity of air introduced remains nearly constant over the load range. A recent series of tests showed a reduction of 15 per cent in the volume of overfire air and reinjection air when the boiler rating was reduced from full to one-quarter load. It is apparent that the overfire air can contribute heavily to the excess air at low load. Fig. 3 illustrates the air flow through the furnace of a system similar to the one from which the data in Fig. 1 were obtained.

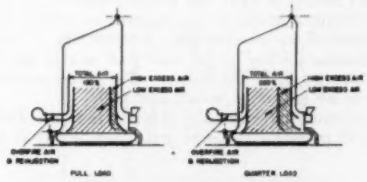

FIG. 3 FURNACE AIR FLOW WITH OVERFIRE AIR FROM ROOM

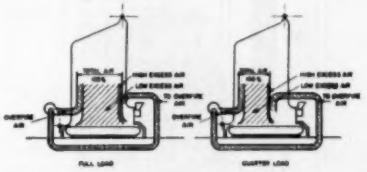

FIG. 4 FURNACE AIR FLOW WITH FURNACE GAS USED FOR FURNACE TURBULENCE

The cold overfire air, when used in sufficient volume to produce turbulence, chills the low-load furnace gases and thus lowers the effectiveness of the air turbulence.

FURNACE GASES FOR FURNACE TURBULENCE

The overfire-air system can be revised, Fig. 4, to boost the furnace temperature and to reduce the excess air at low loads. This system employs the lean furnace gases for turbulence and for conveying fly ash. It is known that the discharge end of the grate operates with a high excess air to insure a burned-out ash. This low-temperature gas of high oxygen content is pulled out of the furnace gas stream and diverted through the furnace turbulence system. The reduction in total flow through the furnace is equal to the overfire-air requirement. A reduction of 25 per cent in air flow through the furnace at low loads has been obtained. The resulting increase in furnace temperature is greater than that gained from 50 per cent increase in load.

GRATE BURNING RATE

The selection of a desirable grate size is often perplexing.

[2] "Application of Overfire Jets to Prevent Smoke From Stationary Plants," by R. B. Engdahl and W. S. Major, Technical Report No. 7, Bituminous Coal Research, Inc., and Battelle Memorial Institute.

TABLE 1 PERFORMANCE OF REAR-DISCHARGE UNIT

Steam flow, lb per hr	49000	105000	175000	280000
Actual grate burning rate, Btu per sq ft per hr	232000	500000	570000	690000
Theoretical grate burning rate, Btu per sq ft per hr	116000	250000	428000	690000
CO_2, per cent	10.7	12.3	14.3	14.5
Stack, Ringelmann	Less than 1	Less than 1	Less than 1	Less than 1

The knowledge that the fly ash increases with the burning rate, or more precisely with the gas velocities in the furnace, has been a check on grate burning rates. An examination of the dust-load curve in Fig. 1 will reveal this characteristic. Nevertheless, a smaller grate would have improved low-load performance. This dilemma is sometimes met on dump-grate stokers by inactivating the rear portion of the stoker when prolonged periods of light load are anticipated.

The shortening of the fire on the more commonly accepted arrangement of the traveling-grate spreader, Fig. 2, is impossible. Pulling the fire to the front wall of this unit would expose bare grates to the furnace. The grates, without air-cooling or ash protection, would soon fail.

The traveling-grate spreader arranged for rear discharge, Fig. 5, can provide a moderate grate burning rate at the top

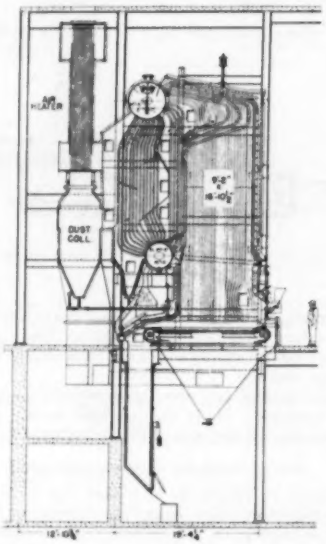

FIG. 5 DISCHARGE TRAVELING-GRATE SPREADER STOKER

capacity and a safe burning rate at low loads. This is illustrated by the performance, Table 1, of a rear-discharge unit having four lateral zones. Two zones were used for the low loads, three zones for the third load, and the full grate was used for the top rating. A load range of nearly 6:1 resulted in grate burning-rate range of 3:1. This unit has preheated air but is not arranged to use furnace gas for turbulence.

Physically, the rear-discharge stoker varies from the front-discharge stoker in arrangement only. The great difference between the three types of grates is in the active grate area, which can be varied on the rear-discharge grates, but which is fixed on the front-discharge and dump grates. The active grate area of the rear-discharge unit can be reduced to 1/4, and in some units to 1/4, of the total effective grate area by closing the lateral zones. When the air is closed on the rear of the stoker the throw of the coal is shortened correspondingly by reducing the distributor speed.

The closing of zones and shortening of the throw of coal can be done only on rear-discharge units. The equivalent is sometimes accomplished in dump grates by covering the rear grate sections with bricks but, obviously, this cannot be done daily. Firing only on the front end of the front-discharge grate would leave the rear grates bare and vulnerable to overheating, but the inactive rear end of a rear-discharge grate is amply protected by ash.

The carbon loss of the rear-discharge stoker is comparable to the front discharge at high loads but there is evidence that carbon loss is less at low loads with the rear-discharge grate. A more complete study of this is under way.

CONCLUSION

The causes of poor low-load performance are numerous. The correction of some causes is the responsibility of the designer and the other causes must be considered operational. Elimination of those causes which are subject to field adjustment will not always eliminate smoke; therefore, we must improve the stoker and furnace designs. Refractory furnaces give relief at low ratings but handicap the high ratings. Preheated air, the use of furnace gas for turbulence and reinjection, and the rear-discharge traveling grate are effective tools for improving low-load performance and are also beneficial for high loads.

Improvement of low-load operation of spreader stokers is a necessity. Deviation from the accepted practices seems desirable for there will be little progress if we assume that the popular path is the only or the best route to our goal.

How to Achieve Smokeless Operation of Spreader Stokers

By D. J. MOSSHART

STOKER DEPARTMENT, WESTINGHOUSE ELECTRIC CORPORATION, LESTER, PA. MEMBER ASME

TWO principal problems are encountered in the operation of spreader stokers at low combustion rates, especially at rates below 200,000 Btu per sq ft of grate per hr. To a certain extent the two problems are interrelated.

The first is that of maintaining operation with excess air at a value sufficiently low for good efficiency. The other is operation without objectionable smoke. It is probably recognized that, with furnace volume adequate for maximum load, the tendency of spreader stokers to produce smoke varies inversely as the rate of combustion.

MINIMIZING EXCESS AIR

Operation with reasonable excess air becomes increasingly difficult to maintain as the rate of combustion is reduced. For satisfactory operation, formation of clinker in the firebed must

be prevented and this requires some increase in the air-to-fuel ratio in the firebed on the grate. This increase of excess air is moderate if distribution of fuel on the grate is truly uniform.

Assuming positive control of primary air, truly uniform distribution of fuel, and absence of setting leakage, the problem of minimizing excess air is one of controlling air admitted over the fire for such necessary items as cooling of feeders, dispersal of fine fuel at the feeder openings, return of cinders to the furnace, and secondary-air jets used to create furnace turbulence.

This problem is simple in its essentials but requires care, diligence, and co-operation of all concerned in the design and application of the unit to provide:

1 An application of the secondary-air system such that all of the paths by which air enters the furnace are under control.

2 Automatic control of all overfire air in relation to boiler load, preferably by means of a separate, adjustable ratio, receiving regulator acting in response to the master control.

3 Application of jets provided for turbulence in such a manner that maximum effect is obtained from minimum air flow.

4 Recognition that the cost of providing adequate apparatus in some manner must be recovered by the vendor, who cannot

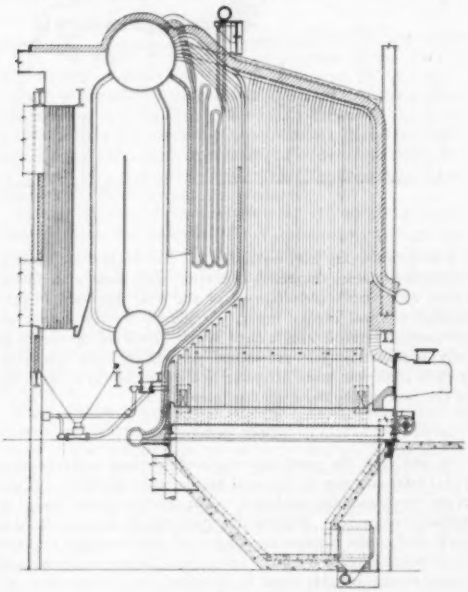

FIG. 1

afford to bid on such a complete installation against competition unless the specifications on which the bids are entered are written clearly to require all bidders to furnish physical apparatus of equal quality.

Adequate provision for operation at low rates with reasonable excess air automatically constitutes a major portion of the solution of the smoke problem. Experience at all installations of equipment of the author's company demonstrates that increase of excess air beyond certain limits results in an increase of smoke.

CAUSE OF SMOKE AT LOW COMBUSTION RATES

The basic cause of evolution of smoke at low combustion rates seems to lie in the decomposition or "cracking" of the hydrocarbon vapors released from the coal before these vapors are mixed with air in quantity sufficient to support their combustion.

When one looks across the fire at grate level he sees streamers of flame—characteristic of spreader stokers—traveling vertically from each particle of fuel as it lands on the firebed.

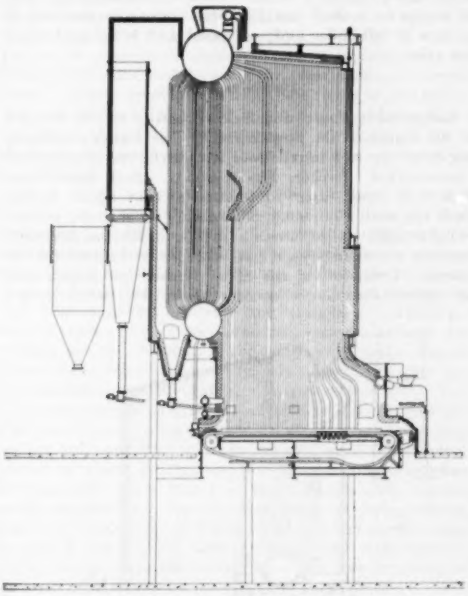

FIG. 2

These streamers have an outer incandescent envelope, where the volatiles receive air around the perimeter of the particle, and an inner core of dark smoky gas which obviously lacks something for complete combustion.

When the observer looks downward toward the fire, as from doors high above the grate, he sees a lacework of black ash between particles and groups of particles of burning fuel. Free air is passing through this ash, and is available for combustion of the streamlets of gas or vapor aligned vertically with fuel particles, if mixture is effected soon enough.

Bending or disturbing in any way the streamers of flame promotes mixture with available air and approach to smokeless combustion.

If the temperature in the region of the firebed is relatively low, decomposition seems to occur without thorough combustion, and free soot can be seen floating away in the furnace atmosphere. Increasing excess air, e.g., by using too much secondary air in an effort to obtain violent turbulence,

lowers temperature with greater detrimental effect on combustion than the benefit obtained from additional available oxygen.

Best results have been obtained in our installations by providing two sets of secondary or overfire-air jets, namely, a row of small nozzles in the rear furnace wall, preferably 12 in. above the grate, and a row of large nozzles in the same wall at 3 ft to 4 ft above the grate. The nozzles are sized so that, at full air pressure, one quarter of the total rear-wall secondary air will flow through the lower nozzles, three quarters through the upper. Maintenance of full pressure on the lower nozzles provides full penetration and maximum turbulence at minimum flow of air.

It is intended that the flow of the lower nozzles will not be regulated, but will be left at one fixed value at all loads. Flow of the upper nozzles is to be controlled automatically; shut off, except for a small flow for nozzle cooling, at less than 25 per cent of full boiler load; increased with boiler load above this value.

DESIGN FACTORS

Additional assurance of smokeless operation may be provided in the design of the furnace itself. The author's company has in service two installations with arch-type or somewhat "bottlenecked" furnace, Figs. 1 and 2. Both installations have been much easier to operate without smoke at low loads and with a minimum of secondary air than the conventional straight-walled furnace. In fact, the first one illustrated employs no secondary-air jets other than the cinder-return system. Deflection of the entire furnace gas stream from its vertical direction of travel at grate level seems to be a large part of what the streamers need to enable them to burn cleanly.

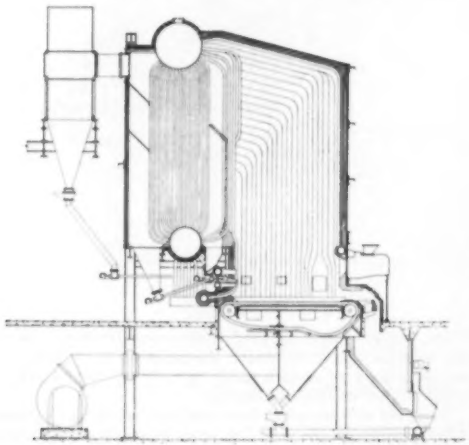

FIG. 3

These remarks are not intended as a blanket endorsement of such designs of furnace but are to report experience with the design in the hope that others having experience with similar designs will report on them.

Experience, in general, has shown that furnaces with refractory walls or with only limited water cooling make easier the problem of obtaining smokeless operation at low rates. However, such furnaces have manifest disadvantages for operation at high rates and, for all practical purposes, reduce the range of available capacity by limiting the opposite end of the scale. It would seem preferable to use a completely water-cooled furnace with a smaller stoker, which combination would give a greater range of operation at a lower combined capital and operating cost.

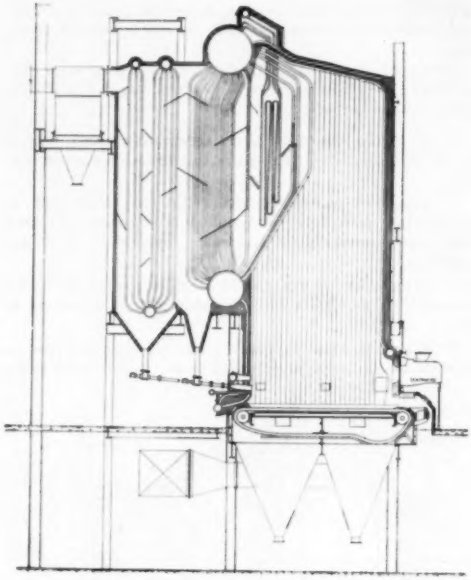

FIG. 4

The use of steam jets, instead of air jets, to provide furnace turbulence enables smokeless operation with somewhat lower excess air. Steam consumption of the jets, expressed in percentage of total energy input, is regarded by the author as economically intolerable except where low-load operation is only occasional. For protracted periods of such operation it pays to devote more diligence and more capital to solution of the problem by more efficient means.

CONCLUSION

In applying the principles outlined in these remarks, material assistance can be rendered by the boiler designer. There is an ever-increasing tendency to cut corners in the design of furnace enclosures. Waterwalls, particularly the rear furnace wall, and cinder hoppers are shortened and crammed into the least possible space with the result that the secondary-air and cinder-return systems must be designed as a compromise between what really should be done and what is physically possible in the space available. Examples of good and bad layouts are shown in Figs. 3 and 4.

Fig. 3 shows a design typical of many of the so-called standardized types of boiler. Constriction of space and crowding of apparatus are illustrated conspicuously.

Fig. 4 shows a different design, also relatively low in cost, where more than ample space is available for the apparatus required.

VISION IN POWER

By PHILIP SPORN

PRESIDENT, AMERICAN GAS AND ELECTRIC SERVICE CORPORATION, NEW YORK, N. Y. FELLOW ASME

THE role of power in the life of a country like ours is out of all proportion to its economic value as determined by price. First produced commercially here some 70 years ago, electric power has today become an indispensable part of the daily living of most Americans: in the home, in community functions, on the farm, and particularly in industry. In the prodigious beehive of industrial activity that constitutes the strength and achievement of this nation, electric power is the energizing force without which most industrial and even home activity would be impossible.

Engaged as we now are in an effort of vast scope to build up our defenses and to strengthen the defenses of other free nations, it is necessary to utilize all our resources to produce armor powerful and plentiful enough to restrain potential aggressors, or to defeat them if war comes. In bringing all this about, power will play a decisive role. It is even more vitally linked with peacetime progress and our ability to continue to grow and provide for the physical and spiritual welfare of an expanding population.

THE TRUE PLACE OF POWER IN OUR NATION

The true place of power in our over-all picture may be gaged better if these introductory statements are expanded.

First, it is much too categorical a statement to say that power and national welfare are synonymous. Power is vitally important in industry, for example, yet in most industry the cost of power represents a bare seven tenths of one per cent of the cost of production. But power can be critically important; it becomes critically important if it is absent.

Second, the role of power is growing. With all the attention that the development of our natural-gas industry has recently been receiving and all the optimistic hopes that are being held out for atomic power, these, after all, are forms of fuel, and fuel is only one element, though an indispensable one, in the development of power. Electric power is the one form of energy that man has been able to produce that is ideal from almost every standpoint in every sphere of man's activity, and this aspect of electric power is constantly gaining greater recognition.

Third, utilization of power is subject to an unusual rate of growth. It is well known that any given rate of growth may be out of the ordinary for one industry and yet be normal or below normal for another. But use of electric energy is still increasing so fast that its growth pattern is not yet fully established. This characteristic of an undefined growth pattern, by any standard of comparison, can be matched only by very young industry. Truly, in the case of electric power, it can be said: Past is but prologue.

Fourth, the importance of power in national defense cannot be overemphasized. Electric power is one of the key factors in mobilizing our industrial resources. This is true of all defense industry. It is especially true of many special war industries developed in recent years in which power plays an even more significant role than it does in such operations as aluminum reduction or in electric steel manufacture. As cases in point we have the atomic diffusion or separation plants at Oak Ridge, the similar plants being built at Paducah, and other nuclear operations in a less advanced stage of technical development which are now also under construction.

Fifth, electric power has a part to play in assuring peace, or in restoring peace if we should have to undergo the ordeal of war. This is because the bringing about of a condition of peace is inevitably linked up with the problem of acceptance by the masses of the world of belief and faith in our system of freedom—political and social-economic. But this in turn is tied to the problem of improving and of kindling hope for further improvement of the lot of the average man all over the world. That improvement cannot come except by mechanization and further improvement in our own productivity as a prelude to helping the less industrially advanced peoples of the earth improve theirs. Of necessity all this involves more electric power.

Sixth, if we are to get maximum utilization of electric power, we need the most economical development and the most economical operation. For only by insisting on such criteria will you bring about the result sought with a minimum call on the country's resources and manpower. Production of electric power is a most complex and unique technical-economic operation. Not only does it require large quantities of capital per unit of capacity and energy produced, transmitted, and distributed, but the economics of the enterprise naturally demand a low rate of depreciation—a rate very close to that provided by consideration of physical life due to wear and tear. This requirement calls for a great deal of advance planning to avoid obsolescence due to inadequacy; that in turn means long reaches into the future. For unless the fog of the future is pierced by vision, neither size nor technical dimensions can be visualized. As a matter of fact, unless social-economic trends are visualized, the very foundation for future systems cannot be developed. In short, sound development of power systems is not possible unless boldness and imagination—vision—in projection and conception are liberally intermingled with technical soundness and economic responsibility.

THE NEED FOR VISION

Vision obviously isn't introduced merely by making engineering studies and evaluations, or economic projections—even though these activities help. The technical studies, as often as not, stop short just at the point where they need very much to advance. To paraphrase John Tyndall—we cannot stop abruptly where our slide-rule value ceases to be of use. Here vision is needed; here special insight and intuition are required to supplement the purely technical judgment. Vision obviously cannot be confined to things physical in a field such as electric power where perception is needed in the social, social-economic, and even political sphere. Like a good many chemical reactions which cannot occur except in a solution of a certain pH, it seems to me that vision is impossible except against a background of understanding of the life of the community, recognition of the aspirations of the various segments of the population, and awareness of the basis of their economic well-being and of their social habits.

To some extent vision has the characteristics of being both swift and transient. In an instant one may see clearly and boldly a full development, a system, or the consequences of a

An address delivered before the American Power Conference, Chicago, Ill., March 27, 1952.

policy, and in that instant he may get a clear basis for judging intrinsic worth, economic soundness, or basic wisdom of each of these, respectively. An almost infinite amount of work may be necessary to fill in various phases of the picture before it can meet, in the light of cold judgment, the test of reason and analysis. It may even be necessary to invent new tools, devices, and organizations not previously tried or known. But unless the end vision is clearly kept in mind these will never come into being, and the end so desirable and desired will never be brought about.

AN EXAMPLE OF GROWTH

The discussion thus far has been very general in character. It should be possible to relate these observations in some measure to concrete experience. Consider, for example, some recent projections into the future made on the American Gas and Electric Company System.

The peak demands of the American Gas and Electric System over a period of a quarter of a century have been as follows:

Year	Maximum one-hour peak demand
1930	614,000 kw
1939	909,000 kw
1951	2,700,000 kw
1954 (estimated)	3,600,000 kw

Thus, between 1939 and 1954, demand will have quadrupled; this is equivalent to a compound growth of 9.6 per cent per year. If this rate of growth should continue to 1970, the system demand at that time will be 15,600,000 kw. The average rate of growth over the period 1930–1950 was 7 per cent. If this rate of growth is used to project to 1970, a demand of 9,300,000 kw is indicated. If the 7 per cent rate of growth is used as a basis of projection from the reasonably certain 1954 demand base, then the demand to be looked forward to in 1970 is 10,700,000 kw. Thus it appears that, depending upon what rate of growth is chosen for the purpose of projection, the 1970 demand that may be expected will vary between 9,300,000 kw and 15,600,000 kw.

Similarly, the application of suitable load factors to the peak-demand projection indicates a possible system input in 1970 of between 37.2×10^9 and 96.0×10^9 kwhr. These compare with the 1951 figure of system input of 15.96×10^9 kwhr.

None of these relatively simple projections have been accepted as serious indicators of what demand and system input are likely to be in 1970. But they have been catalytic in generating a view of a possible growth and development—of there coming into being a complete power system—simply unimaginable only a few years ago. And, they have served to bring into focus a host of problems that will be pressing for solution, some of which had not been encountered previously and others which, while they may have been met earlier, will appear in a form so much sharper and more critical as to constitute new problems. As the implications of the outlook are scrutinized, two things are plain:

(*a*) Demands of the order indicated will never come about unless they are visualized, prepared, and worked for, and

(*b*) The solution of practically all of the major problems incident to such enormous increase in demand will never be achieved or be worked out soundly unless they are visualized and developed in congruence with the main vision.

What is that main concept? I believe its outlines are quite clear:

A social-economic institution closely intertwined with the economic functioning and therefore dedicated to meet the requirements in its service area—existing, growing, and expandable to the maximum extent in the future, even when quadrupling of present limits is indicated—on the part of all classes of consumers: urban-residential, rural, commercial, industrial, municipal, county and state, and other governmental; utilizing for that purpose new aids and instrumentalities, technical and economic—some developed by others, and some by the company itself—to carry out the functions of generation, transmission, and distribution in the most reliable and most economical manner, and so developing utilization of electric energy to the utmost. The objective of all this? To promote the security and social-economic welfare of the community and the citizens it serves, and of all the people cooperating in rendering that service—the owners, managers, supervisors, and the thousands of members of its large family of employees.

The conception goes farther. It includes in its scope service and worth. It definitely reaches a horizon of social usefulness and responsibility as a basis for maximum assurance of continuing to function. This, in effect, merely recognizes the danger of a vacuum created by failure to respond to opportunity or need. Of course, indispensable prerequisites to assurance of continuity of function are trust and confidence in the ability of the country, its institutions, and its people, to progress and move forward.

VISION AFFECTS PLANNING

With that outlook clearly before one, the many problems, some quite difficult, brought about by such growth and expansion as I have indicated, fall into their logical places and all can be worked out and in harmony. Planning, building, staffing, operating, and the problems associated with all of them, take their cue from the main theme.

Consider, for example, the problem of generation and the question of generating-plant sites. Who, in the light of the prospects I have indicated, can become careless with a good site or indifferent to the importance and value of developing prime sites sufficiently ahead of need to be sure of availability when actually needed? Who can project a program that involves underdevelopment or underprojection of a good site?

Or examine the basic question of fuel. With quantities of energy of the order indicated to be generated, fuel as the one indispensable and most important element in providing mass generation of electric energy becomes something more than a commercial commodity to be obtained as needed by asking for bids from prospective suppliers. The importance of exploring a whole series of questions—sources, reserves, technical and economic soundness of entrepreneurs, becomes apparent. And the question of the competitive position of various fuels: coal, oil, gas, char, when and if it becomes a significant commercial commodity, and atomic fuel, when and double "if" it becomes a commercial item—all of these fall into their proper places both as to the present, and in time scale as well.

Again, consider the question of turbine and boiler sizes. I have been told of system planners or executive directors who within the past year or two had declared that they *never* would have need for units above a certain size, say, 50,000 or 60,000 kw. I do not say that this particular rating could not have been the ideal rating for that particular system at a certain time. Nor would I deny that larger-sized units bring with them additional technical and economic problems. But it must be obvious that only those who visualize inadequately can hobble themselves and the system they project by categorical prejudgment as to what size they will or will not permit to be utilized in the growth and development of their system.

(*Continued on page 479*)

ECONOMICS *of* NATURAL GAS *and Liquefied* PETROLEUM GASES

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INTRODUCTION

REFERENCES to natural gas may be found in the very early history of mankind. Velikovsky (1)[3] states that the fiery destruction which is said to have occurred at the time of the Hebraic exodus from Egypt resulted from hydrocarbon gases in the atmosphere of a wandering comet. These gases, contacting the earth's atmosphere, caused tremendous conflagrations. In ancient Persia the followers of Zoroaster contemplated burning seepages of natural gas and worshipped them as awesome manifestations of divinity. In more recent times, in early America, our ancestors likewise encountered burning springs of natural gas and looked upon them as manifestations of divinity to be utilized for the welfare of man. Today in America we have a gas and oil industry which is the envy of the rest of the world, while the Persians have a petroleum industry owned by foreigners, controlled by politicians, and of no important use to anyone but simply the basis for international political trouble.

The natural-gas industry as we find it here today is purely an American development, the product of free enterprise unhampered by traces of ancient superstitions or by foreign traditions derived from the ideologies of feudal Europe. In America no modern-day robber baron stands astride the gas mains demanding a tribute in cents per ton, and no liege lord makes a treaty to sell the services of serfs to the users of gas. So our American natural-gas industry has grown and is continuing to grow in the best tradition of free men working in a free economy. Some of the results of this growth will be analyzed in the material which follows and some of the threats to further growth will be pointed out.

NATURAL-GAS PRODUCTION IN UNITED STATES

At this time natural-gas production in the United States is about 7.5 trillion cu ft annually, representing a growth of more than 50 per cent since the end of World War II. Although this growth has been phenomenal, the present-day known reserves of natural gas are larger, both relatively and on an absolute basis, than the corresponding reserves of crude oil. On an absolute basis and reduced to the common denominator of therms (100,000 Btu) known natural-gas reserves, including the liquid content, are 59 to 60 per cent of the total known petroleum reserves of the United States. Crude oil as such represents only 40 to 41 per cent of the total. The large reserves of natural gas have been discovered mainly as an incident to the exploration for crude oil. Relatively, in terms of current use, the United States has proved reserves of gas equal to about 25.5 years' supply; proved reserves of natural-gas liquids equal to about 19 years' supply, while the corresponding figure for crude oil is only 13 years (2, 3).

Of course, the supply of crude oil will not be exhausted in 13 years even if we make the unrealistic assumption that there will be no new discoveries. The oil in the present known reserves simply cannot be produced in 13 years, and we would makeshift to get along on less oil over a greater number of years. The same reasoning applies—perhaps not so emphatically—to the reserves of gas and related liquids, including liquefied petroleum gas. Actually we know that new reserves are being discovered every day. The years' supply figure for crude oil has been substantially constant at about 13 years for several years past. The years' supply figure for gas, since 1945, has decreased from about 34 to 25.5 at present though actual new discoveries each year have been in excess of production. An appraisal of the future oil and gas supplies of the United States is contained in a recent report (4) made by the U. S. Geological Survey primarily for the information of Congress. This report, which was released by the Secretary of the Interior on March 2, 1951, includes a significant statement worthy of quotation:

"No precise statement as to the amount of potential reserves of oil and gas in the United States can yet be made. If the future can be judged by the past, oil and gas will be found in sufficient quantities for many years to come. In the United States adequate production has been a direct function of economic incentive. Until the unpredictable date at which that incentive fails to provide the needed supplies, there will be no convincing evidence that we have reached the limits of our ability to expand the potential ultimately recoverable reserves of petroleum."

The greater relative supply of natural gas has, of course, been an important factor in the rapid growth of gas use during the past 6 years. However, government regulation affects the distribution and use of natural gas much more than of crude oil and its products. It is generally assumed that a public-utility service, gas for instance, can be rendered most economically by a monopoly in any one community or general area. Further, even in the American system dedicated to free enterprise and competition, it has been accepted that a public utility is regulated by government in consideration of monopoly either tolerated or expressly granted by the same government. Whether present federal regulation of interstate natural-gas lines is in accord with the foregoing principle we will not attempt to say. Certain it is that some groups would establish vague standards of "public interest" as a basis for extending regulation even to basically competitive activities. In any event, present regulatory practice is to require a showing of 20 to 25 years' assured supply of gas before permitting new interstate lines or major expansions of present lines.

Within the next few years growing use of natural gas will bring the years' supply figure to an equilibrium value of, say, 23. Beyond that time further growth in transportation and distribution will be limited by new discoveries. It will, in effect, be necessary to discover about 1 trillion cu ft of new reserves

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[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

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for every 100 million cu ft of daily capacity that is added to the natural-gas system of the United States. Presumably such added discoveries will be made for a long time to come if the "economic incentive" is adequate.

SOURCES OF ENERGY

Total energy use in the United States (excluding firewood, and the like) was 35,137 trillion Btu in 1950 (5). The record high use was 36,689 trillion in 1948. The year 1951, for which complete data are not at hand, will probably set a new record. Sources of the energy used in 1950 are given in Table 1.

TABLE 1 SOURCES OF ENERGY IN THE UNITED STATES, 1950

	Trillions of Btu	Per cent
Gas (including LPGas and other natural-gas liquids)	7548	21.5
Crude oil	11475	32.6
Subtotal, petroleum	19023	54.1
Coal	14542	41.4
Water power	1572	4.5
Totals	35137	100.0

Depending on use, the various sources of energy meet at different competitive levels. A detailed comparison, Table 2 is based on prices in this general area. This comparison does not consider differences in utilization efficiency or utilization costs. For a very large boiler installation, for instance, industrial coal at 3.4 cents per therm could possibly attain the same thermal efficiency as gas. This would only be done with increased operating cost and a materially greater investment in facilities, so that gas, if available at 4 cents per therm, might still be the cheaper fuel. It would seem, however, that natural gas will gradually cease to compete for bulk fuel uses such as steam generation. There are various reasons for this, but the really basic reason is the growing demand for gas for superior uses. By superior uses is meant those uses for which coal cannot readily compete, that is to say, uses in which the cleanliness and convenience factors of gas outweigh costs.

If gas is to be eliminated from the bulk markets this should happen not through unwise end-use regulation but rather through natural competitive developments. In many cases large-scale interruptible bulk sales have provided the very livelihood of a natural-gas pipe line which otherwise could not have existed and served its domestic users at the widely varying demands which characterize gas consumption by such users. With increasing demand for and market value of natural gas, other means will be found for serving the fluctuating needs of the superior users as low-price bulk sales decline. Storage reservoirs near points of heavy use can absorb the surplus gas transported during summer months and make it readily available during the winter months of heavy demand. Notable progress already has been made in states such as Oklahoma, Ohio, and Michigan in the use of depleted oil and gas sands for such seasonal storage. Another method is to pump the gas into a natural aquifer where geological structure is favorable, creating a man-made gas field where none existed before.

Fuel oil, in competing for the industrial market, cannot offer the very low cost of coal nor is it quite as convenient in utilization as natural gas. Where natural gas is not available, and where cleanliness and close control are important, distillate fuels will find industrial markets. Residual fuels have their best competitive appeal where mobile combustion utility is a factor, marine and railroad use being instances.

For home heating, coal finds difficult going in competing with natural gas. Efficiency and cleanliness are real differences which affect the over-all-cost comparison, reducing the price disadvantage of gas. For convenience and comfort most users probably would allow gas one or two cents per therm. The distillate fuel oils are more expensive and somewhat less convenient than gas, and manufactured gas, while convenient, is a poor last costwise in competing for the modern job of home heating. In analyzing the cost of gas for home heat the low end of the usual rate schedule has been assumed to apply. Usually gas rates (6) for the first 30 therms (3 Mcf) per month are relatively high to take care of at least part of the fixed cost of service. Rates for added volumes per month are materially less. The first part of the rate may reasonably be assumed to apply against cooking and general domestic use.

TABLE 2 COMPARATIVE ENERGY COSTS FOR VARIOUS SOURCES AND USES

Type of use	Source	Unit	$/unit	$/therm
Industrial	Coal	ton	9.25	0.934
Industrial	Fuel oil, residual	gal	0.087	0.058
Industrial	Fuel oil, No. 2	gal	0.100	0.072
Industrial	Fuel oil, No. 1	gal	0.1095	0.081
Industrial	Nat gas, if available	Mcf	0.40	0.040 (c)
Home heating	Coal	ton	16.00	0.057
Home heating	Fuel oil, No. 2	gal	0.126	0.090
Home heating	Fuel oil, No. 1	gal	0.139	0.102
Home heating	Nat gas (a)	100 cf	0.075	0.075
Home heating	Nat gas (b)	therm	0.095	0.095
Home heating	Mfg gas	100 cf	0.085	0.157
General domestic	Electricity	kwhr	0.042	1.231
General domestic	Electricity (water heating)	kwhr	0.0125	0.366
General domestic	Mfg gas	100 cf	0.110	0.204
General domestic	LPGas	gal	0.180	0.180
General domestic	Nat gas (a)	100 cf	0.103	0.103
General domestic	Nat gas (b)	therm	0.152	0.152

Btu values used	
No. 1 fuel oil	136000 per gal
No. 2 fuel oil	140000 per gal
Residual fuel oil	150000 per gal
LPGas	100000 per gal
Nat gas	1000 per cf
Mfg gas	540 per cf
Coal, industrial	13500 per lb
Coal, domestic	14000 per lb

1 therm = 100,000 Btu

Notes

(a) Detroit, Mich., rates (6)
(b) Milwaukee, Wis., rates (6)
(c) Purely assumed

Unless otherwise noted the prices per unit approximate those for Charlotte, N. C., as of December, 1951

For such general domestic use only the "convenience" sources of energy are included in this comparison. On price basis alone natural gas is far and away the best bargain. And the related LPGas is second with manufactured gas third. These three fuels reasonably may be assumed to have the same efficiency of utilization. If electricity is to be considered for such domestic uses as cooking and water heating, very large convenience and efficiency values must be assigned to offset cost. Presumably electric water heaters may be nearly 100 per cent efficient. If so, a water heater using LPGas would break even on energy cost with only 50 per cent efficiency. Actually, of course, these appliances have a much higher efficiency than 50 per cent. For general domestic use natural gas claims an advantage over electricity in terms of reliability. Gas is brought to the user in underground mains unaffected by the

sleet and snow of winter, untouched by the wind and rain of summer.

ECONOMIC INCENTIVE FOR PRODUCERS

Now that we have analyzed briefly the competitive strength of natural gas in supplying our various energy needs, it is appropriate to reconsider the question of "economic incentive" mentioned earlier. Just what are the producers receiving for the gas that serves so well, at low cost? About 88 per cent of the known gas reserves of the United States are in the five southwestern states of Texas, Oklahoma, Kansas, Louisiana, and New Mexico (2). In these states producers delivering to interstate lines are now receiving from 6 to 10 cents per Mcf, i.e., 0.6 to 1.0 cent per therm. Comparing this with rates in representative northern cities (Detroit and Milwaukee) it is immediately evident that the cost of gas in the field is only about 10 per cent of the cost paid by the consumer at the other end of the pipe line. So a 50 per cent increase in field price represents a 5 per cent increase in delivered cost. Doubling the present field price represents a 10 per cent increase in delivered cost. From the consumer's standpoint these are comparatively minor charges to pay for the assurance of adequate natural-gas supplies. But from the producer's standpoint these same increases represent 50 to 100 per cent, an effective economic incentive to induce:

1 Exploration for new gas reserves.

2 Offering gas reserves on the interstate market rather than holding them for industries at home.

At present no important new gas reserves are available for pipe-line contracts at less than 10 cents per Mcf, with a figure of 12 cents being asked for more favorably situated production. To get long-term contracts, which are desirable to safeguard investment in long gas lines—and in effect required by regulation—it is necessary to include price escalation clauses in purchase contracts. A typical 20-year contract starting at 10 cents per Mcf may provide for a price increase of 0.5 cent every 2 years, thus reaching 14.5 cents during the last 2 years of the 20-year contract. An offer to sell large reserves of natural gas at a starting price of 15 cents escalating to 18 cents in 20 years has just recently been announced. This offer is under serious consideration by a pipe-line company which plans to export the gas to Canada.

The confused situation regarding possible Federal Power Commission regulation of gas sales at the source has helped, no doubt, to push the field price of gas higher. Many large gas producers fear the possible effect of Federal Power Commission regulation on their related oil operations. This has at times resulted in important gas reserves being held off the market, or at least held for a higher price to compensate partly for the risk of regulation. Summing up the natural-gas situation:

(*a*) If a free market is permitted at the source, the price of natural gas probably will reach 15 to 20 cents per Mcf based on present purchasing power of the dollar.

(*b*) At such price level, exploration for gas itself will become extensive.

(*c*) Such new exploration not only will maintain the necessary 23 years' reserve for present pipe lines, but also will provide added reserves for expansion of the natural-gas distributing industry.

(*d*) Regulation which produces artificial scarcity of gas also will reduce the supply of LPGas.

LIQUEFIED PETROLEUM GAS

Almost all natural gas contains more or less liquefiable hydrocarbons. These range from ethane through propane, butanes, pentanes, and other gasoline-range compounds, on through kerosene, Diesel oil, and heavy, waxy oils. The latter three occur only in so-called condensate fields where the gaseous mixture is present at temperatures and pressures beyond the critical. Such reservoir fluids give up their heavy liquids upon reduction in pressure. This phenomenon is usually referred to as retrograde condensation.

The bulk of natural-gas-liquids production consists of LPGas (propane and butanes) and natural gasolines. The natural gasolines find their principal outlet in the blending of conventional motor fuels. A considerable amount of natural-gas butanes is similarly used. Discussion of this use is not properly a part of the present paper and further remarks will be confined to LPGas.

LPGas as marketed in the United States today consists mainly of propane and butanes from natural gas with smaller, but important amounts of the corresponding fractions from refinery gases. With respect to use for heat and internal-combustion-engine power, there is no important difference between the refinery products and the natural-gas products. However, the refinery propane and butane fractions are the products of destructive decomposition of heavy petroleum fractions and contain substantial percentages of the olefins, i.e., propylene, and the various butylenes. These olefins are not handicapped by the chemical aloofness which characterizes the paraffins, and hence the refinery LPGas fractions are of particular interest to the chemical manufacturer who would produce alcohols, ketones, and polymers such as butyl rubber.

The physical properties of these hydrocarbons, Table 3, have

TABLE 3 PROPERTIES OF NATURAL LPGAS COMPONENTS

	Propane	Iso-butane	Normal butane
Weight, lb per std gal	4.23	4.69	4.86
Cf of vapor per gal	36.45	30.65	31.79
Btu value, gross per gal	91300	99300	103000
Btu gross, vapor per cf	2521	3259	3267
Vapor pressure at 100 F, psia	189.5	73.5	52.0

Source: Technical Standard 2145, Natural Gasoline Association of America, 422 Kennedy Building, Tulsa 3, Okla.

an important effect on their recovery, storage, and transportation. Generally speaking, high pressures combined with lower temperatures are necessary for extensive recovery of propane, and the product must be stored at a minimum pressure of about 200 psi. Butanes, if not mixed with propane, can be handled at a minimum pressure of about 60 psi. The difference between these two storage pressures represents roughly the relative difficulty of recovering the two hydrocarbons in liquid form.

Natural LPGas products are recovered in field plants which may process either gas-well gas or oil-well gas. About two thirds of all gas production is from gas wells and is comparatively low in recoverable liquid content. About one third is gas produced from oil wells which, on the average, will contain twice as much recoverable liquid per unit as the gas-well gas. Thus the two sources are approximately equal in total liquid potentials. Average recoverable liquid content of all gas production in the United States has been estimated to be 2.16 gal per Mcf (3). This is the total including both natural gasoline and LPGas.

In the early history of the industry, extraction of hydrocarbon liquids was undertaken in order to make the gas transportable by pipe line. Such operations were commenced in West Virginia as early as 1907. At the present time total annual recovery of these field plants is in excess of 205,000,000 bbl (7), Fig. 1. Of this amount over 86,000,000 bbl is LPGas consisting of about 44,000,000 bbl of propane and 42,000,000 bbl of butane. This supply of natural LPGas is augmented by about 19,000,000 bbl

of refinery products, this being the net of refinery sales over refinery uses of natural LPGas.

There is a large potential volume of unrecovered propane and butanes in the natural-gas streams and in refinery gases of the American petroleum industry. Studies reported previously (3) estimated this unrecovered potential to be about 140,000,000 bbl annually from total natural-gas production. Probably the bulk of this potential is available in the many smaller streams of gas utilized locally in the oil and gas fields, in the streams delivered for local distribution, and in supplies to local industries including carbon-black plants. Usually the major transcontinental pipe lines are served by large, efficient extraction plants in the fields, and many of these lines derive their supplies from the gas fields of the Gulf Coast area which contain relatively low concentrations of propane and butanes. Other investigators (8) have reported a potential of 90,000,000 bbl actually unrecovered from refinery gases.

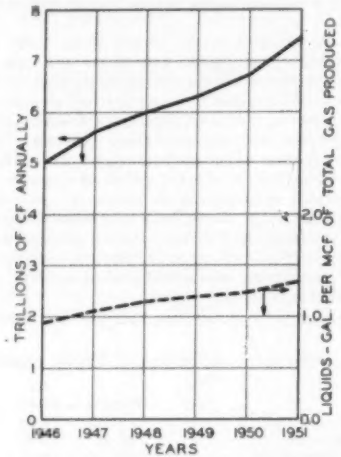

FIG. 1 PRODUCTION OF NATURAL-GAS LIQUIDS

TABLE 4 PROPANE-BUTANES SUPPLY AND DEMAND, 1951

	M bbl
From natural gases	86250
From refinery gases[a]	32620
Total supply[b]	118870
Disposition:	
Natural-gas products used as refinery raw materials (propane and butanes)	13558
Exports	300
Synthetic rubber[c]	8190
Reported LPGas sales	97620
Total accounted for	119668
Discrepancy and losses (0.67 per cent)	—798
Reported LPGas sales consist of the following:	
Domestic and rural	68300
Chemical	17860
Industrial and miscellaneous	5460
Gas manufacturing	6000
	97620

[a] Does not include refiners' own uses, also does not include large pipe-line sales to affiliated chemical plants.
[b] November and December, 1951, estimated.
[c] Not included in LPGas marketing statistics.

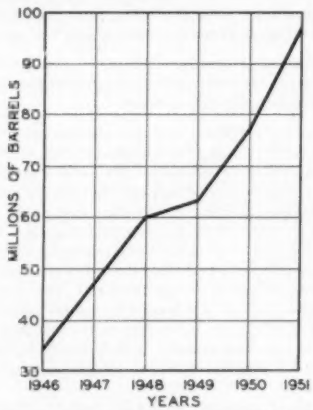

FIG. 2 REPORTED SALES OF LIQUEFIED PETROLEUM GAS BY YEARS

ECONOMIC CONSIDERATIONS

Of course, it is reasonable to inquire why we have scarcity and allocation—in effect rationing—in the presence of such "theoretical" abundance. The answer comes back to the question of economic incentive. As a preliminary to discussing that thought we may first analyze the uses of LPGas as estimated for the year 1951 (9), Table 4, Fig. 2. Chemical utilization, which has grown rapidly, still represented only 22 per cent of total consumption while domestic and farm use took up 57 per cent of the total. In other words, the most important chemical reaction of propane and butane from a strictly economic standpoint is the combustion reaction with oxygen. Industrial and miscellaneous use amounted to about 4 per cent of the total, the remainder being accounted for as refinery raw material and in gas manufacture. Industrial use of LPGas has tended to become less important with the growing availability of natural gas in the busy industrial states of the Great Lakes and Appalachian areas.

Formerly gas-processing plants in the fields relied principally for their income on the recovery of natural gasoline. Favorably situated plants recovered propane and butanes incident to their main operation, and such incidental recoveries supplied the comparatively small demand for these products. Since about 1940, the costs of installing and operating gas-processing plants have increased greatly. For instance, compressors which once cost $85 per hp installed now cost $250. A competent plant operator who was paid 98 cents per hr now receives $1.86. Other instances could be cited at great length but in general we can say that the foregoing comparisons are representative of all costs involved in the processing of gas. Thus it has been fortunate for the industry that new products came into demand to bear part of the growing costs. Also, it has been necessary that these new products do bear some part of the basic costs of selling, administration, and management.

Essentially the problem of increased availability of LPGas is the problem of converting more propane to the liquid phase. As propane recovery is increased plant cost is increased. Present-day plants may be designed for recovery of 95 per cent of the butane and practically all of the gasoline contained in a gas stream with recovery of about 40 per cent of the available propane. Although over-all industry experience shows that only about 20 to 25 per cent of propane in all natural gas is now recovered as liquid, this low average results from the fact that many streams of gas are not processed or are processed only through small, semiobsolete, old-type plants. Propane recovery of 40 per cent

of available represents the basic level for postwar gas-processing plants and this may be increased to, say, 60 or 80 per cent depending on the economics of particular situations.

COMPARATIVE PRODUCTION STUDY

A somewhat detailed engineering study has been made for two plant projects selected at random. This is purely a study to determine the relationship between cost per gallon and increasing liquid recovery from the gas. The results are to be considered on a relative basis only and do not represent the absolute over-all costs of any particular gas processor. These projects represent (*a*) a very rich gas capable of yielding about 6.6 gal of total liquids per Mcf, thus with minimum recovery costs per gallon; and (*b*) a gas capable of yielding about 1.9 gal of total liquids per Mcf, thus only slightly leaner than the average and by no means the extreme in low-content gases which are processed for liquid recovery.

The essential assumptions used in this engineering study are explained briefly as follows:

(*a*) Raw material value is taken at 1 cent per gal for the gas equivalent of propane. On today's present market price of 4 cents per gal f.o.b. plants this represents 25 per cent, which is the customary amount credited to gas producers for the right to extract propane from their gas. On the basis of Btu value this 1 cent per gal is equivalent to 11 cents per Mcf for 1000 Btu gas, which is about the going market for large, new supplies of gas to pipe lines from gas wells or processing plants.

(*b*) Extra operating labor and costs incident to the recovery, storage, and shipping of propane have been estimated on a marginal basis in each case.

(*c*) Tank cars for the shipment of propane are expensive because of the high-pressure construction and insulation required. Cost of these cars has increased almost 50 per cent since 1944, the present quoted price being $10,200 per car, if steel can be made available to fabricate them at all. Frequently these cars can only be operated at an irregular load factor because of varying seasonal demand for LPGas. A tank car charge of not less than 0.375 cent per gal has been found necessary, based on general industry experience, to maintain the cars and amortize their cost over a reasonable period of time.

(*d*) Capital costs have been computed on the assumption that the plant investment will be written off in 10 years. The operating life of gas-processing plants may range from 5 or 6 years in some oil fields to 15 or more years in other oil fields and on gas pipe lines. Where the available reserves are sufficient to provide a very long life, obsolescence and deterioration of equipment become the limiting factors in plant life. Because of the risks involved, an average write-off period of 10 years is not considered unreasonable. Interest is charged at 6 per cent on the unamortized balance, being equivalent to about 3.3 per cent annually on the entire capital. Insurance and taxes are charged at 2.5 per cent. This makes the total capital costs 15.8 per cent annually. As in the case of operating labor, only the marginal investment is considered.

(*e*) Seasonal storage is required in the case of plants undertaking high propane recovery. We have assumed that such seasonal storage will come into the situation when the propane recovery exceeds 60 per cent of that available. The capital cost of such storage is included with other capital costs. Additional operating costs are required depending on the form and location of the storage. Generally, heavy steel storage is uneconomical for this purpose, at least in so far as the producer is concerned, though some consumers, notably utilities, find it possible to install large numbers of steel tanks for seasonal requirements of propane. The producer normally will attempt some form of underground storage such as a cavity mined out of shale between layers of impervious limestone. Another form of underground storage is the solution cavity in subterranean salt beds. Such cavities are made by drilling wells to the salt zone, circulating water into the well through tubing and back to the surface through the casing to dissolve sufficient salt to create a large cavity. Underground storage of either type preferably should be located in areas of large consumption of LPGas rather than near sources of production. Otherwise, the bottleneck of transportation may make it impossible to use the storage advantageously. Extra costs of underground storage include the costs incident to recovering the liquid from the storage and reshipping it, and the volume losses incurred in such operations.

Assuming in each case that the propane carries only 1 cent per gal to cover basic costs of doing business such as overhead, administration, sales, and, of course, state and federal income taxes, we may then add the marginal costs specific to the handling and recovery of propane. On this basis we find that the cost for 40 per cent propane recovery from the exceptionally rich gas is 2.8 cents per gal and from the more nearly average lean gas 3.5 cents per gal. To the extent of the 1-cent-per-gal basic cost, these figures for 40 per cent propane recovery are arbitrary and probably on the low side. It may be noted that the market price f.o.b. plants is now approximately 4 cents per gal.

The plant engineer and economist who considers increasing his propane recovery from 40 per cent to 60 per cent finds that the added recovery costs him 0.7 cent per gal more than the basic recovery in the case of the plant processing rich gas, Fig. 3.

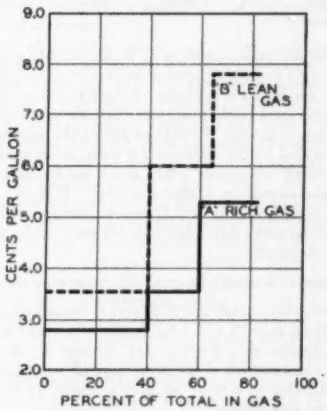

FIG. 3 MARGINAL COSTS VERSUS PER CENT RECOVERED NATURAL-GAS PROPANE

For the plant processing lean gas the added recovery costs almost 2.5 cents more per gal. Taking a simple arithmetic average of the two we might conclude that an economic incentive of 1.6 cents per gal over the present 4-cent price would increase the available supplies of propane by 50 per cent. This represents 22,000,000 bbl per year. Incident to this added recovery of propane there would be an increase in butane recoveries, possibly on the order of 15,000,000 bbl per year. Also, it is believed that this economic incentive actually would yield more than the estimated 22,000,000 bbl of propane because of the inducement for modernization of small, old-type plants and because of the fact that it would make possible the installation of new plants in situations which cannot now justify any plant at all.

Carrying the study of economic incentive and availability a step further, we note that the plant processing rich gas would

require a price increase of 2.5 cents per gal to justify recovering 80 to 85 per cent of the available propane in the gas stream, while the lean-gas plant would require an increase of 4.3 cents. Again averaging these figures we have a marginal price differential of 3.4 cents which would bring another 22,000,000 bbl per year or more onto the market. Added butane recovery on the order of 5,000,000 bbl yearly could reasonably be expected.

Most of the plant problems with which the natural-gas-processing industry is concerned will fall within the range of the two cases selected for our study, though the total volumes of propane and LPGas available from lean gas such as case (*b*) will be several times that from the very rich gas of case (*a*). In a free economy, price is the regulator which adjusts supply to demand. If the supply, be inadequate an increased price will tend to increase that supply and this is particularly true in a case such as we are now considering where there is a large unrecovered potential supply. The general relationship between supply and price outlined in the foregoing discussion is given in Table 5.

TABLE 5 RELATIONSHIP BETWEEN SUPPLY AND PRICE

	Price at plants, cents per gal	Supply propane, M bbl per year	Butane, M bbl per year	Total LPGas	Increase per case, M bbl
Present	4.0	44000	41000	86000	
60 per cent recovery basis	5.6	66000	57000	123000	37000
80 per cent recovery basis	7.4	88000	62000	150000	27000
Total increase					64000

The total incremental supply of 64,000,000 bbl annually corresponds to an average economic incentive of 2.5 cents per gal increase in the price f.o.b. plants. Of course, no one operator or group of operators could guarantee these figures. Inflation, for instance, could change the magnitude of the economic incentive represented by the figure of 2.5 cents, or shortages of steel and processing equipment could delay producers in their efforts to take advantage of that incentive. However, generally speaking, increased price will bring out increased supply. Material shortages may delay but will not prevent the working of economic incentive.

FACTORS GOVERNING CONTINUED GROWTH OF INDUSTRY

Of course, the availability of LPGas is basically dependent on the continued growth and good health of natural-gas distribution and processing. Without any increase in extraction efficiency, normal growth in the processing of natural gas can provide an increase of 6 to 8 per cent annually in the available LPGas from this source.

There is some question whether present rural and domestic uses of LPGas can provide a satisfactory outlet for large increases in supply. There is particularly the problem of seasonal variations in demand. To illustrate the effect of this seasonal demand on supply we may point out that production of natural LPGas in the summer months of 1951 averaged about 1,200,000 bbl less per month than during the winter months. Thus had the market demand been more uniform the total available supply in 1951 could have been increased by over 6,000,000 bbl and this increase would have been largely low-cost material. The question of seasonal storage has been discussed already and greater use of this expedient will effect a large improvement; however, this is not the complete solution to the problem.

The distributor and dealer serving the needs of LPGas consumers cannot live and maintain an efficient organization during the summer months on stocks in seasonal storage. He needs some minimum volume of business to carry his overhead costs, maintain stabilized employment for his key personnel and, in short, to stay in business as an efficient operator. Motor-fuel uses of LPGas can provide these summer markets. This is not to suggest that you will drive your personal car into filling stations and ask to have the tank filled with 80 lb "superpropane," but rather that propane and butane will supply specialized motor-fuel needs. Among such specialized needs may be listed urban buses, truck fleets having definite and regular routes, farm tractors, and many other rural uses such as irrigation pumps. Increased price incentive can provide the larger supplies of propane and butane required to serve these specialized motor-fuel needs and at the same time without pricing the products out of the general domestic and rural market. The rural consumer of LPGas can help in this development by using the product in as many ways as possible and by providing sufficiently large storage on his farm to carry him through winter periods of peak demand. Naturally the same storage tank that contains LPGas for heating and cooking can be used for tractor fuel or irrigation pump fuel.

A PRODUCT OF FREE ENTERPRISE

We have stated that 88 per cent of the natural-gas resources of the United States are located in five states of the southwest. It goes without saying that the reserves of liquefied petroleum gas are similarly concentrated in these states. Periodically there have been suggestions that these states embargo the export of gas to the rest of the United States. The threat of price-fixing by the Federal Power Commission on gas at the source of production no doubt has been a factor in leading some of the gas-producing states to fix minimum prices. The more enlightened viewpoint of those interested in gas and LPGas production in the southwest is to deplore any type of price-fixing, either minimum or maximum, and to ask only the right to sell their products on a free and open market.

In discussing the economic incentives which we believe will bring out added supplies of LPGas, it is not suggested that these be guaranteed, rather that those who must take the responsibility for putting money in expensive gas-processing plants should be free to sell the products for whatever price they will bring in arm's-length transactions just as you would prefer to sell the products of your tobacco fields and textile plants. If the gas producers and processors of the southwest can enjoy that basic freedom of our American system, then the benefits of natural gas and liquefied petroleum gas will be widely available to citizens in all sections of the United States. As an alternate there will be regulation with artificial scarcity. The palsied hand of bureaucracy will touch and shrivel the fruits of free enterprise. In the rural homes meals will be cooked with wood or coal. The urban home will be heated with coal. These conditions will prevail in all but a few favored states where large reserves of gas are immediately at hand.

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What Are the Opportunities in ENGINEERING *and* SCIENCE?

By CAREY H. BROWN[1]

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A TYPE of advertisement quite unusual to the Rochester newspapers has appeared there a number of times during the past year or more. I refer to the help-wanted ads for engineers and scientists. In so far as the ads are concerned, they have been directed at engineers rather than scientists. Perhaps the engineer is considered more susceptible to the newspaper approach than his professional running-mate—perhaps he is considered less fixed in location—or both. These ads, and like ones appearing with greater frequency in the metropolitan dailies, are evidence of the existing shortage of engineers and scientists. This shortage is acute in certain industries and areas, less acute in others, and perhaps for the time being, reasonably well satisfied in other localities.

Advisedly I have said "for the time being," since the shortage is destined to become more severe and more widespread in the years just ahead. In the vernacular, "things will get worse before they get better." This will surely occur in spite of the efforts of engineering organizations to improve the situation. The output of the engineering colleges up to and including 1955 is practically fixed by the present enrollment. Through transfers, or as a result of increased efforts to reduce mortality, the number of engineers graduating in the years 1952–1955 may be somewhat increased, but not substantially so.

What is the prospect for graduates in these next four Junes? Based upon present enrollment in engineering courses and upon normal attrition, these figures can be quite definitely stated at 26,000 in 1952, 20,000 in 1953, and only 17,000 in 1954. These figures are in contrast to a class of 52,000 in 1950, all of whom were absorbed immediately. In 1955, the figure will be slightly higher than in 1954, but probably well under 20,000, unless there is an unprecedentedly high transfer rate resulting from increased appreciation by students now in college of the facts that are now being publicized. Actually the expectancy of such transfers is limited. Usually the engineering curricula include mathematics and physics in the freshman year to such an extent that transfers from other courses would have difficulty in catching up on these subjects except at the cost of delay in graduation.

CAUSES OF DECREASED ENROLLMENT IN ENGINEERING COURSES

The fundamental cause of the diminishing supply of engineering graduates is the low birth rate of the early 1930's. At the present time this affects not only engineering enrollment but college enrollment in general. We are now in the very trough of the curve of 17–18 year-olds. Possibly we may have passed the trough in so far as engineering freshmen are concerned, since enrollment in 1951 slightly exceeded that of the previous year.

Another factor leading to decreased enrollment of engineers was the wall chart and data issued by the Bureau of Labor Statistics some two or three years ago, indicating that engineers would be in oversupply. These data, I must admit, were supported by the statements of some industrialists. However, they were based upon false conclusions as to the demand of American industry and the extent to which the large classes of engineering graduates resulting from the G. I. Bill would supply this demand.

In reality the postwar classes, supplying a peak of 52,000 engineer graduates in 1950, only served to offset the meager supply of the war years, when engineering training for able-bodied males practically ceased. Engineer graduates had reached a low of 8000 in 1945. The policy of staying technical education during the war in order to provide men for the Armed Services was, to say the least, of doubtful desirability. The long-term results proved very serious. The present shortage would be even worse except for the facts that the interruption was relatively short and that G.I.'s flocked to the engineering schools after the war was over.

The result of all these factors is a present shortage of engineers estimated at 60,000 up, depending upon the degree of conservatism of the estimator. Present annual demand has been placed at 30,000, exclusive of the needs of the Armed Services. Graduations for some time to come will fall short of meeting the annual demand, to say nothing of cutting into the backlog. That is my reason for the earlier remark that the situation will get worse before it gets better.

Superimposed on this pent-up demand, we have the rapidly accelerating technological development which brings new demands and new opportunities to the engineer and scientist almost every day. That this is not a mere flash in the pan is indicated by long-term statistics as to the growth in numbers and importance of the engineering profession. What I have to say applies equally to the scientist. The work of one, in industry at any rate, is generally closely related to that of the other. My statistics refer to engineers, however, since the Engineering Manpower Commission has devoted more specific attention to them than to the general field of science. The ratio of engineers in industry to total industrial employees in 1890 was 1 to 300; in 1906, 1 to 200; in 1930, 1 to 100; and now 1 to 50. Where will it stop?

The impact of the Korean war and of the present defense effort is an important factor at the moment, but if the experience of World Wars I and II is of any value, it teaches us that periods of such defense effort result in delayed demands for technological improvements in industry, which serve to augment rather than diminish the demand for scientific and engineering talent when the war ends. Then there are the new fields resulting from the discoveries and research of the military establishment and its civilian employees.

THE FASTEST GROWING PROFESSION

Engineering seems destined to continue its role as the fastest growing profession. The engineer is challenged by developments in atomic energy, television, and the whole electronic field, the new drugs, plastics, and metallurgy, jet propulsion,

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Presented before the Engineering Society of Detroit, March 6, 1952.

and the like, just as in the past he has been challenged by the steam engine, the railroad, the telegraph, the telephone, the automobile and the radio, the washing machine, the deep freezer, the combine, and other devices to increase the productivity of industry and agriculture, decrease manual labor, and generally add to the comfort and convenience of life. Exemplary of the advance in one relatively small field is the statement of a prominent manufacturing chemist that 90 per cent of the stock of a present-day pharmacy was unknown to the trade 10 years ago.

The problems with regard to the present shortage of engineers fall in general into two categories. The first relates to the utilization of engineers now available and the second relates to steps to be taken to increase the future supply.

The problem as to utilization of the present supply is greatly complicated by the military situation. There is no means of assuring the use of engineers as such when they are called into the Service, whether through the draft, from the Reserve, or by other means. This results in undue depletion of the civilian supply. The Engineering Manpower Commission has endeavored to establish the principle that engineers in uniform must be directed into assignments which will utilize fully their engineering abilities. In addition to such efforts directed toward establishing the principle, we also have presented for consideration a great number of individual cases of misapplication of engineering training and ability. Considerable progress has been made in this respect but the situation is not as it should be.

We cannot hope to match our potential enemies in numbers of men. We must out-design and out-produce them in order to emerge victorious. It is in our engineering, scientific, and productive skills that our superiority lies. Those elements of the military services which are particularly concerned with the development, design, and production of weapons are beginning to realize the impact upon their responsibilities of the present shortage of engineering and scientific personnel. Such realization on their part should go far toward persuading the military establishment itself that engineering and scientific talent must not be wasted. In line with the old "guns and butter" idea, it apparently has been the belief of the military establishment, at least until recently, that the concern of industry over the shortage of engineers is based on the fear that there would be a shortage of "butter." More and more it is being realized that unless steps are taken for the better utilization of technical skills there will be a shortage of guns as well as of butter.

But it is not merely essential that technology develop and produce the weapons and equipment essential to the maintenance of military superiority. It must, at the same time, carry out its major share in the development and production of articles of such attractiveness, usefulness, and serviceability to the civilian economy that the cost of military preparedness can be borne. The wreck of our civil economy would be as disastrous as military defeat. Maintenance of strength in our civil structure as well as in our military establishment is essential. In both, the role of the engineer is a dominant one, supply of engineering manpower is a critical problem, and failure to make full utilization of available engineering skills is a wasteful procedure which must be eliminated.

Efforts to secure better utilization of engineers in the Armed Services are often met with the accusation that private industry is doing a poor job in this respect. No doubt that is true in many cases. At the risk of being told that I take a negative position with regard to utilization in industry, I believe that we can look for best results, not as a consequence of any action which we can take now, but as a result of the workings of the law of supply and demand. The nature of the activities of engineers engaged in sales, purchasing, and the like varies so much from place to place that it is impracticable to make any sound generalization with regard to justification for the use of engineers in such positions during an emergency. Two factors enter the situation. The first is that engineers who have been so employed for any considerable length of time probably now lack knowledge of the skills and techniques essential in the fields of design, development, and mechanical or chemical production, where our greatest needs exist. Another factor is that engineers who are nonessential in their present positions, whatever they may be, probably will be drained off into more essential engineering activities as the demand for their services makes itself felt. However, industry is urged to take all possible steps through upgrading of present engineers, shortening the period of training for new men, and so on, to make maximum utilization of present personnel.

PROVIDING AN ADEQUATE FUTURE SUPPLY OF ENGINEERS

Provision of an adequate future supply of engineers constitutes an entirely different problem. The present shortage is so deep, and the prospective long-range demand so great, that the attack upon this problem must be fundamental. The first requisite is to supply to our boys, and to a certain extent to our girls too, the incentive and the desire to undertake an engineering career. To accomplish this we must take steps to develop a more widespread knowledge of what the engineer does and of the importance of the engineering profession to the American way of life. America's high standard of living is due to its productivity. Here 6 per cent of the world's population produces 50 per cent of the world's goods. In this accomplishment the engineer's role is outstanding.

At the present stage in our history we have two major problems, which more or less merge into one. One is the successful solution of the military problem which now confronts us and which may be with us for some time. Another is the preservation of the American way and the American standard of life through this crisis and beyond, by further advance under the system of private enterprise and industrial development to which the engineer has contributed so significantly. There is much reason to believe that, while heretofore we have considered ourselves as living in the technological age, we actually have only been approaching that age. Recent advances in science have been so rapid that the engineer is challenged as never before. It is our function to translate these advances into means for the survival of our civilization and for an ever-improved standard of living. The engineer's role, his opportunities and responsibilities, are destined to become greater and greater as science continues its advance.

MANY OPPORTUNITIES FOR THE ENGINEER

Outlets for the skill of the individual engineer are varied. The scientist and the engineer co-operate in research and development. Design of buildings, machines, equipment, and installations of all sorts is the engineer's primary function. It is entirely logical, however, that the engineer find his place in the fields of production, sales, or service. Many an industrial establishment, particularly one engaged in the production of machinery or mechanical equipment, feels that most of its major activities should be headed by engineers. Engineers have unusual opportunities to rise to the positions of top management in industry as is so clearly evidenced by the numbers who have done so. The military services and the civilian branches of Government offer many opportunities. Civil engineers in particular find a major outlet for their work in the activities of highway construction, water supply, sewage disposal, and the like, which are to a large extent the concern of governmental

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COMMERCIAL BURNER OIL SPECIFICATIONS

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ON January 9, 1929, a joint conference of refiners, distributors, and consumers of fuel oil, and manufacturers and distributors of oil burners, adopted a recommended standard for domestic and industrial fuel oils. This was published by the Department of Commerce, Bureau of Standards, as Commercial Standard CS 12-29.

In 1933, 1934, 1938, and 1940, revisions were adopted and promulgated by the Bureau of Standards. On September 28, 1948, the latest revision was approved by the Bureau. It was drafted by Technical Committee E of the American Society for Testing Materials, Committee D-2, and it is called CS 12-28.[1]

The value of these standards is discussed from the viewpoint of the refiner, the distributor, the burner manufacturer, and the general public; suggestions are made as to further revisions in order to improve these standards and to protect the interests of the groups mentioned. Also, an additional revision of the standard fuel-oil specifications is suggested so that the refiner and oil distributor, as well as the burner manufacturer and ultimate burner owner, may know exactly what oil should be used in a particular burner and the results that may be expected from the use of such oils. The manufacturer should be able to recommend a certain grade of oil for his burner, and the burner owner should be able to buy that grade of oil and feel sure that it always will operate properly in his burner.

SIGNIFICANCE OF VARIOUS CHARACTERISTICS[2]

In general, we may say fuel oils must be free from highly volatile constituents, the presence of which would constitute a fire hazard, and be practically free from water and sediment which might clog lines and valves. The sulphur content should be low because of the possibility of forming sulphuric acid with resulting corrosive action. The oil must be fluid at all times, so that it can flow freely through the feed system, and its viscosity or internal friction must be low enough so that it can be atomized effectively. The amount of free carbon or carbon residue in the oil must be low enough to prevent clogging of burner parts and prevent the formation of carbon and ash on boiler or furnace heating surface. In certain types of burners the end point is important, as it indicates whether the oil will volatilize and burn completely and produce a minimum amount of carbon. The 90 per cent point (the temperature at which 90 per cent of the sample is distilled) is a more practical index. The 10 per cent point may be used as an index of the ease of ignition.

The oil-burner industry is trying to establish a new unit of comparison of the burning qualities of various oils. Various units of comparison have been proposed (D. W. Locklin),[3] such as the following:

Aniline point (ASTM Test Designation D 611–43 T).
IP smoke test.
Carbon-hydrogen ratio.
Per cent aromatics (sulphuric-acid absorption test).

Combinations of various tests have been proposed and some tests made by Locklin and Parmelee,[4] such as the Diesel Index, which is a formula combining the API gravity with the aniline point. The IP cetane number is the formula combining the API gravity with the 50 per cent distillation point. The UOP characterization factor is a formula combining the specific gravity with the average boiling point. The burning index is a chart combining the API gravity with the 50 per cent distillation point. The carbon-hydrogen ratio estimation is a chart combining API gravity, aniline point, and boiling point.

No conclusive proof has been submitted that any of these tests can be used as an index of the burning characteristics of oils; and so the characteristics of flash point, pour point, viscosity, gravity, free carbon, and end point must be relied on.

Gravity. The density of an oil is usually expressed as specific gravity or according to the API scale, which is slightly different from the Baumé scale. The API is expressed by the formula

$$\text{Degrees API} = \frac{141.5}{\text{Specific gravity } 50/60\,\text{F}} - 131.5$$

However, in actual practice the API gravity is determined by a specially calibrated hydrometer. The specific gravity reveals in a general way the proportion of light and heavy constituents present. Except in analyses of lighter oils, it is of minor help in classifying fuel oils. It does provide a convenient means of checking the uniformity of a product in blending operations and in calculating the weight of oil for shipping purposes.

Flash Point. The presence of volatile constituents is ascertained by a determination of the flash point. This is the temperature at which an explosive air-vapor mixture is formed. The instrument used for this test is the ASTM Standard Pensky-Martin closed tester. The lower the flash point, the easier it is to ignite the oil, but the more hazardous is the handling of the oil. An oil with a high flash point requires preheating in order to ignite it. Flash point is not a reliable measure of the volatility of the oil.

Fire Point. The temperature at which an oil gives off vapor rapidly enough to ignite and continue burning is called the fire point. Flash point and the 10 per cent distillation temperature are better indications of the ease of ignition.

Pour Point. The pour point of an oil is the lowest tempera-

[1] "Fuel Oils," Commercial Standard CS 12-48, sixth edition, U. S. Department of Commerce.

[2] "The Significance of Tests of Petroleum Products," ASTM Committee D-2 Report, 1946.

Contributed by the Fuels and Oil and Gas Power Divisions and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[3] "Progress in Evaluating Fuel Oils," by D. W. Locklin, presented at the Convention of the Oil Heat Institute of America, Chicago, Ill., April 3, 1951.

[4] "Rating of Fuel Oils by a Test Unit," by D. W. Locklin and G. V. Parmelee, *Heating Piping & Air Conditioning* (ASHVE), vol. 22, December, 1950, pp. 121–127.

ture at which it will flow. It is directly related to the paraffin content and the crystal size of solidified paraffin. The pour point of an oil depends on the source of the crude oil and on the method of refining. Since the pour point is determined under test conditions somewhat different from actual operating conditions, the pour point is an indication rather than an exact temperature at which an oil can be pumped.

The required pour point depends somewhat on the climate; but in general it may be stated that if an oil will flow readily at the temperature at which it is to be handled, the oil has a low enough pour point and does not need to be kept warm. If the oil has too high a pour point, not only will it have to be kept hot in the tank, but warm oil will have to be circulated continually through the oil pipes at a high enough temperature so that it will not congeal. Temperature-viscosity charts show a viscosity of 400 seconds Saybolt Furol (SSF) as an average maximum viscosity for pumping, and 2000 SSF as a top maximum viscosity. A heavy oil of 300 SSF at 122 F would have to be heated to about 115 F to be pumped. An oil meeting the maximum specifications for No. 5 oil according to CS 12-48 would have to be kept at 70 F in order to be pumped. As pointed out, an oil with a considerable paraffin content would require a higher temperature. Therefore it may be said that the pour point and not the viscosity is the determining factor in judging whether an oil is free-flowing.

If an oil has a pour point of 10 F or lower and is stored in a tank buried below the frost line, with supply and return lines of sufficient size also below the frost line, it can be expected that no trouble will be experienced in pumping it.

Sediment and Water. The presence of excessive sediment causes burner trouble owing to accumulations in tanks, clogging of strainers and burner tips, and carbon deposits in furnaces and boilers. An additive is frequently used to keep the sediment, sludge, and water in suspension. An excessive amount of water in the oil can cause ignition trouble, an unsteady fire, and corrosion of burner parts. Water that accumulates in the bottom of a tank may cause corrosion of the tank.

It is customary to specify freedom from water and sediment for light domestic fuel oils. The water and sediment are measured by the percentage by volume as determined by centrifuge. This is commonly called BS&W. An automatically operated burner should use an oil having a BS&W of less than 0.5 per cent, and a manually operated heavy-oil industrial burner should not have a BS&W of over 1 per cent.

Viscosity. While viscosity may be defined as the measure of the resistance of an oil to flow, its importance is as an indicator of the ease of atomization of the oil. Viscosity of the oil indicates the type of burner that must be used to atomize it and the temperature to which it must be raised. Viscosity is probably the most important characteristic of an oil.

Viscosity is significant not only because of its direct influence on the performance of a burner, but is important when considering the handling and storage of fuel oils.

The performance of all oil burners depends on the viscosity of the oil used, since viscosity affects the ease with which the oil can be atomized.

The viscosity of an oil decreases as the temperature is raised, and thus an oil with a viscosity so high that it cannot be atomized properly, sometimes can be burned efficiently by preheating it.

TYPES OF BURNERS

In general, certain grades of oil are best adapted for particular types of burners, and the operator of a burner should be able to order oil by the grade number for the particular type of burner which is to be used.

Vaporizing Type. While some pot-type vaporizing burners have been built to operate on No. 2 oil, in general these burners operate most satisfactorily on No. 1 grade fuel oil. If the fuel used is too heavy, there is a tendency for carbon to form in the bottom of a pot-type burner. The maximum end point should be held at 625 F, and the gravity should not be less than 35 API.

Wall Flame. The wall-flame burner operates on No. 1 or No. 2 oil. This type of burner throws the oil out on a horizontal plane and burns at the edge of a hearth.

High-Pressure Oil Atomizing. This type of burner pumps oil at 100 psi or more pressure through a small nozzle orifice which breaks the oil up into small particles in order to atomize it. This type of burner is most common when used as a domestic burner in sizes up to 6 gph. It is the author's experience that when nozzles of larger capacity are used, the oil is not atomized as finely and is not burned as satisfactorily as with a smaller nozzle. It is also his experience that when nozzles of smaller than 1 gph are used, trouble is experienced with clogging of the nozzle orifice. Therefore it can be said that the capacity range of this type of burner should be between 1 and 5 gph; although burners with smaller capacities are sometimes used, and a considerable number of burners of this type with larger capacity are in use. An oil of No. 2 grade is suitable for this type of burner, although No. 1 oil may be used if desired.

In Commercial Standard No. 3 fuel oils used previous to 1948, the viscosity of this oil, which was used in high-pressure oil-atomizing burners, was limited to a maximum viscosity of 45 seconds Saybolt Universal (SSU) at 100 F. Glendenning, Black, Ventres, and Sullivan[8] found that if an oil of higher viscosity is used, good combustion cannot be obtained. The amount of oil delivered by a pressure-atomizing burner nozzle may increase as much as 25 per cent with a change in viscosity from 34 sec to 50 sec. They also found that the viscosity of an oil not only affects the output of a nozzle, but it also affects the angle of spray, which must coincide with the angle of air delivery. They conclude that viscosity influences nozzle capacity, angle of spray, degree of atomization, character of flame, and efficiency of combustion.

Considerable progress has been made in the past several years in order to improve this type of burner by adapting various types of secondary-air diffusers. In this way the new catalytic-cracked oils can be burned satisfactorily. Without these improvements, burning quality decreased, ignition was poor, and nozzles clogged. It is difficult to make a burner that will burn 100 per cent catalytic-cracked refinery distillates as well as blends with thermal-cracked oils. However, the new advances in secondary-air swirlers and cones have eliminated this trouble to some extent.

It will be noted that the proposed oil specifications limit No. 2 oil, which is meant to be used in pressure-atomizing burners, to a maximum viscosity of 50 SSU at 100 F, whereas the present specifications limit the maximum viscosity of No. 2 oil to 40 SSU at 100 F.

Low-Pressure Air-Atomizing Burner for Domestic Use. These burners operate with low-pressure oil at 1 to 3 psi, and the air pressure is substantially the same as the oil pressure. Since the oil is atomized by air pressure, the nozzle orifices can be larger, and it is therefore possible to burn less than 1 gph using catalytic-cracked oils without clogging the nozzles. A poorer grade of oil can be used in this type of burner than in the high-pressure burner just described, but the proposed No. 2 oil is suggested for this type of burner.

[8] "Atomization of Oil by Small Pressure-Atomizing Nozzles," by E. B. Glendenning, A. R. Black, L. H. Ventres, and W. A. Sullivan, Trans. ASME, vol. 61, 1939, pp. 373–381.

Low-Pressure Air-Atomizing Burner for Industrial Use. This type of burner has been developed in sizes up to 60 gph and is of particular value in the field of commercial and industrial oil burning in a range of 3 to 40 gph where completely automatic operation is desired. Air pressure as high as 30 psi is used, and oil with a viscosity up to 350 SSU at 100 F can be atomized easily. An advantage of this type of burner is that lighter oils, as well as the heavier ones, may be used. Since air pressure is present, it is easy to design a forced-lubrication-oil system for lubricating the air pump and for operating low fire start and modulating air motors.

The viscosity of the fuel oil used in this type of burner need not be held to as close limits as in the high-pressure burner. Small-orifice nozzles are not used, but the oil burned is metered through a positive-displacement pump and is atomized by the use of air. Since this type of burner is designed for completely automatic operation in commercial or industrial establishments, it is recommended that an oil no heavier than the proposed No. 5 oil be used in this type of burner.

Horizontal Rotary Cup. Horizontal rotary-cup burners are commonly used to burn the heavier bunker oils. They are better adapted for manual or semiautomatic operation than for completely automatic operation. The percentage of turndown on this type of burner is not great, and it is necessary to keep the rotating cups very clean if good atomization is to be obtained. There are many horizontal rotary burners with full-automatic controls operating with cold No. 5 oils with completely satisfactory results; and there are even burners of this type operating under full-automatic controls and burning preheated No. 6 oil and preheated heavy No. 5 oil. However, this type of burner is most satisfactory when used with manual or semiautomatic controls. Burners of this type that are most common use a primary-air fan immediately back of the atomizing cup in order to help atomize the oil being broken up by the centrifugal action of the spinner cup. It is desirable to preheat oil for use in this type of burner.

Other Types of Burners for Burning Heavy Oils. Burners with very high-pressure air and burners using steam for atomization are also used to burn the heavier bunker oils.

OIL SPECIFICATIONS

Table 1 is a chart showing former, present, and proposed oil specifications. The first column shows the specifications of Commercial Standard CS 12-40; the second column shows Commercial Standard 12-48; the present specifications; and third column shows the proposed specifications.

The specifications for No. 1 oil should be proper so that it may be used in a vaporizing pot-type burner. The main changes made in 1948 were to eliminate the maximum flash point, increase the carbon residue from 0.05 per cent to 0.15 per cent, increase the maximum 10 per cent distillation point from 410 to 420 F, increase the end point from 560 to 625 F, add limits of viscosity and a minimum gravity specification of 35. These new specifications proved satisfactory, and it is not suggested that they be changed further, since the present specifications have been satisfactory with pot-type vaporizing burners. It is important that any No. 1 oil be used successfully in this type of burner.

The specifications for No. 2 oil should be proper for use in a high-pressure oil-atomizing burner or in a low-pressure domestic burner. Its maximum specifications should be such that any No. 2 oil will perform properly in this type of burner. The characteristics of an oil to do this were described earlier in the paper. In 1948 the specifications were changed to eliminate mention of maximum flash point, which had been 190 F; to raise the maximum pour point from 10 to 20 F; to permit water and sediment of 0.10 per cent instead of 0.05 per cent; to increase the maximum carbon residue expressed in per cent maximum on 10 per cent residuum from 0.25 to 0.35; and to increase the maximum 90 per cent distillation point from 600 to 675 F. These maximum specifications allow oils unsatisfactory for the foregoing uses to be marketed.

The main changes proposed at this time for this grade of oil will limit the maximum pour point to 5 F. Since this oil is used in most domestic burners, it is important from the viewpoint of the oil refiner, the vendor, the burner manufacturer, and the user of the burner that any No. 2 oil meeting the specifications will be satisfactory for use in the burner. An oil with a pour point of higher than 5 F will not flow easily enough to furnish the burner with a steady supply of oil under all conditions, and, therefore, it is important that the pour point be limited to 5 F. It is believed that this will not cause the oil supplier any serious inconvenience.

Since it is recognized generally that an oil with a viscosity greater than 50 SSU will not atomize properly, will not give the proper spray angle, and will not deliver the correct quantity of oil, it is felt that it is essential to limit the maximum viscosity of this grade of oil to 50 SSU. Since tests have shown that 50-sec oil cannot be ignited as easily as 40-sec, the latter figure is used.

The specifications of 1948 eliminated No. 3 oil, and No. 2 oil generally has been furnished for burners which formerly used this grade. It is felt that this was a wise move and that there is no particular type of burner for which the old No. 3 oil would be used instead of No. 2 oil. Therefore it is proposed that the elimination of the No. 3 grade of oil be continued.

At the time of the elimination of No. 3 oil, a new grade No. 4 oil was substituted. This oil had a maximum viscosity of 125 SSU at 100 F. Since this oil was too heavy for use in high-pressure domestic burners, and since a heavier oil than this can be used in No. 5 oil burners, it is felt that No. 4 oil did not serve any useful purpose and it should be eliminated from the proposed specifications.

The specifications for No. 5 oil were changed in only one particular in 1948. The minimum viscosity was increased from 50 SSU at 100 F to 150 sec. The reason for this change evidently was to allow a place for the No. 4 oil, and since it is proposed that No. 4 oil be eliminated, the minimum-viscosity specifications should be returned to 50 sec. In addition to this, it is felt that the specifications for this oil should be changed so that it could be used for any industrial burner that did not require preheating. The present No. 5 oil specifications range from a very light oil to an extremely heavy oil that requires considerable heat for preheating. The proposed changes limit it to a maximum pour point of 10 F, which is low enough so that if the tanks and lines are installed properly, the oil will flow readily to the burner without preheating. The maximum viscosity is limited to 350 SSU at 100 F, instead of the old maximum of 40 SSF at 122 F. The latter Saybolt Furol viscosity is equivalent to a viscosity of about 900 SSU at 100 F, and this is far too high for a No. 5 oil. It is felt that the water and sediment maximum specification of 1 per cent is too high and should be reduced to 0.5 per cent, and that the carbon residue expressed in per cent maximum on 10 per cent residuum should be limited to 1 per cent in order to eliminate excessive carbon and ash deposits on boiler surfaces.

The changes proposed would allow a very great range for No. 6 oil, and it is therefore proposed that this heavier oil be divided into two grades, one to be known as No. 6, having a maximum viscosity of 45 SSF at 122 F, and the other as No. 7 oil, reaching all the way up to 300 SSF at 122 F.

Fig. 1 shows the present Commercial Standard Specifications CS 12-48 plotted on an ASTM Standard Viscosity Temperature Chart for Liquid Petroleum. The known values are

TABLE 1 COMMERCIAL STANDARDS

No. 1 Oil	CS 12-40	CS 12-48	Proposed
Flash point, deg F (max)	165	....	...
Flash point, deg F (min)	100 Or legal	100 Or legal	100 Or legal
Pour point, deg F (max)	0	0	0
Water and sediment, per cent (max)	Trace	Trace	Trace
Carbon residue, per cent (max on 10 per cent residuum)	0.05	0.15	0.15
Ash, per cent (max)	.....	....	...
Distillation, 10 per cent point, deg F (max)	420	420	420
Distillation, 90 per cent point, deg F (max)	.....	....	...
Distillation, end point, deg F (max)	560	625	625
Viscosity, SSU at 100 F:			
Maximum	.....	33.3	33.3
Minimum	.....	30.4	30.4
Gravity, API, minimum, at 60 F	.....	35	35
No. 2 Oil			
Flash point, deg F (max)	190	....	...
Flash point, deg F (min)	110 Or legal	100 Or legal	110 Or legal
Pour point, deg F (max)	10	20	5
Water and sediment, per cent (max)	0.05	0.10	0.10
Carbon residue, per cent (max on 10 per cent residuum)	0.25	0.35	0.35
Ash, per cent (max)	.....	....	...
Distillation, 10 per cent point, maximum, deg F	440	440 in Other than atomizing burners	...
Distillation, 90 per cent point, maximum, deg F	600	675	675
Viscosity, SSU at 100 F:			
Maximum	.....	40	40
No. 3 Oil			
Flash point, deg F (max)	230	....	...
Flash point, deg F (min)	110 Or legal	....	...
Pour point, deg F (max)	20	....	...
Water and sediment, per cent (max)	0.10	....	...
Carbon residue, per cent (max)	0.15 straight	....	...
Distillation, 90 per cent point, deg F (max)	675	....	...
Distillation, 90 per cent point, deg F (min)	600 Unless gravity is 26 or lower	....	...

No. 3 Oil (cont'd)	CS 12-40	CS 12-48	Proposed
Viscosity, SSU at 10 F:			
Maximum	45	....	...
No. 4 Oil			
Flash point, deg F (max)	.....	....	...
Flash point, deg F (min)	.....	130 Or legal	...
Pour point, deg F (max)	.....	20	...
Water and sediment, per cent (max)	.....	0.50	...
Ash, per cent (max)	.....	0.10	...
Viscosity, SSU at 100 F:			
Maximum	.....	125	...
Minimum	.....	45	...
No. 5 Oil			
Flash point, deg F (max)	.....	....	...
Flash point, deg F (min)	130 Or legal	130 Or legal	...
Pour point, deg F (max)	.....	....	10
Water and sediment, per cent (max)	1.00	1.00	0.5
Carbon residue, per cent (maximum on 10 per cent residuum)	.....	....	1.00
Ash, per cent (max)	0.10	0.10	0.10
Viscosity, SSU at 100 F:			
Maximum	.....	....	350
Minimum	50	150	50
Viscosity, SSF at 122 F (max)	40	40	...
No. 6 Oil			
Flash point, deg F (min)	150	150	130 Or legal
Pour point, deg F (max)	.....	....	...
Ash, per cent (max)	.....	....	0.10
Viscosity, SSU at 100 F:			
Minimum	.....	....	350
Viscosity SSF at 122 F:			
Minimum	45	45	..
Maximum	300	300	45
Water and sediment, per cent (max)	2.00	2.00	1.00
No. 7 Oil			
Viscosity, SSF at 122 F:			
Minimum	.....	....	45
Maximum	.....	....	300
Water and sediment, per cent (max)	.....	....	2.00

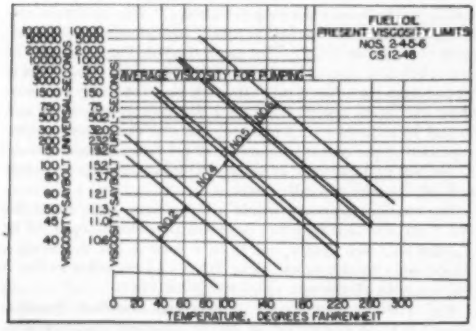

FIG. 1

plotted on this chart and a straight line drawn through them. The ordinates of the chart are constructed so that the viscosity of the oil may be read from the lines so drawn. The viscosity of the present No. 2, No. 4, No. 5, and No. 6 oils is shown. A horizontal line is shown at a viscosity of 400 SSF. Where the upper limit of No. 5 oil crosses this horizontal line is the point at which No. 5 oil must be heated in order to pump it. It will be noted that this is 70 F, which is much too high for a burner using oil that is not preheated. From this figure it can be seen that No. 4 oil is much too heavy for a pressure-atomizing burner.

Fig. 2 shows the proposed No. 5, No. 6, and No. 7 grades. A study of this chart will show that No. 2 oil with a maximum viscosity would be suitable for domestic burners. The line of this viscosity is the same as the line of minimum No. 5 viscosity. No. 5 oil would be suitable for industrial burners that do not require preheating, and Nos. 6 and 7 oils would be proper in the type of industrial burner that requires preheated oils.

In Fig. 2 curves showing the various grades of Navy bunker oils are also plotted. It will be noted that bunker A is shown as a curve instead of a straight line, and this chart was made to show the viscosity characteristics of any oil as a straight line.

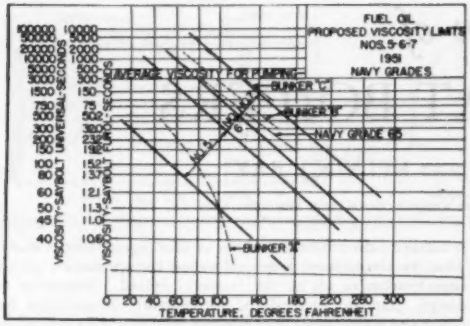

FIG. 2

However, the specifications as issued by the Navy for bunker A when plotted on this chart show a curve. These viscosity specifications[6] are given as a method of comparison because the term "bunker C" is in common use and is often thought to be another name for No. 6 fuel oil. It is interesting that bunker B and bunker C oils are so close together.

SUMMARY

New specifications to replace Commercial Standard CS 12-48 are necessary.

Specifications for No. 1 oil would not be changed.

Specifications for No. 2 oil should be limited to a viscosity of 50 SSU at 100 F and to a pour point of 0 F.

No. 3 oil should continue to be eliminated from the specifications, and No. 4 oil also should be eliminated.

No. 5 oil should be limited to a maximum viscosity of 350 SSU at 100 F, the carbon residue limited to 1 per cent maximum, and a top limit of 10 F pour point should be used.

No. 6 oil should be limited to a maximum viscosity of 45 SSF at 122 F.

Oils heavier than No. 6 should be specified as No. 7 fuel oil.

If the user of an oil burner can be assured that he can purchase oil by number and receive the proper fuel for his burner, as recommended by the manufacturer and the oil supplier, great assistance will be given the distributor of fuel and the manufacturer of burners, and the ultimate user of the burner will receive a much higher degree of satisfaction.

Vision in Power

(*Continued from page 466*)

Or take the questions of temperature, pressure, and cycle in the modern steam-electric plant. All the heated arguments as to whether 900 psi 850 F constituted or did not constitute a natural limit to further progress in thermal and economic efficiency, and all the fear, uncertainty, and hesitation as to whether to reheat or not to reheat, show up in their true perspective in the illumination furnished by a broad picture of the system and development ahead. How, in the light of expansion potentials such as I have indicated, can one rest on present limits of performance as long as science and technology are opening up new vistas?

For a period of years we have been having controversial discussions about the economics of this or that extra-high voltage—220, 287, 330, and even 400 kv. I have heard engineers of standing and accomplishment say that they could never see the usefulness of any higher voltage than 220 kv. And yet it is obvious this is no subject that can even be half rationally studied and analyzed until something more than present or relatively close-at-hand system projections are made and studied. Here in particular, the view of a system going well beyond anything that is called for in the present is a necessary prerequisite for technical development, and for bringing about economic realization in the form of savings in capital and operating costs.

Of all the elements that have to be brought together in a soundly conceived and efficiently functioning electric-power organization, none is as important as people—the people necessary to visualize, plan, build, direct, and operate. People endowed with skill, people trained in many specialized fields, people of character—productive people. But, in a complex industry like ours, such people can only be found and are only available when needed if they are brought into the industry at the right time, and if subsequently they are properly trained and permitted to develop. But if this need isn't projected and communicated to others—to those directing the affairs of our secondary schools, of our colleges and technical schools, to the faculties of those schools and to their students—how can one expect young people to become enthusiastic about allying themselves with a visionless industry? How can you expect them, by their demand for training and instruction, to exert pressure strong enough so as to bring into being schools adequately equipped and manned by faculties of high competence and inspiring leadership?

It seems clear to me that the personnel problem—the problem of bringing in the right people and the problem of keeping them inspired, happy, and productive—can only be solved with many years of effort as a part of the conception of the long-term picture of the industry. Without this vision, the realization will be patched, partial, inadequate, inefficient, and uncertain. Given this outlook, it can be made whole, fully adequate, sure and harmonious in its functioning, and highly efficient and productive.

Industry today is confronted by problems that, in terms of size and scale, go beyond anything that could have been reasonably projected only a relatively few years ago. For example: One large power group is today wrestling with a problem recently placed before it as a result of our expanding defense effort that in the power field, at any rate, has never before been even remotely approached from the standpoint of size, complexity, and multiplicity of ramifications. I have participated, over the past six weeks, in a great many discussions in an attempt to work out a solution. Almost every new discussion reveals a number of new facets of the problem; this in turn presents invitations to go off on attractive by-paths. The number of these would seem to be almost inexhaustible. But the solution of the problem does not lie in exploration of any of these by-paths. If the problem is not visualized in its whole, and all its parts placed in the context of the whole, the solution as a whole will most certainly be exasperatingly difficult, and perhaps impossible.

It seems to me that the same basic relationships apply to and govern all other fundamental problems of the power industry. If, on top of its achievements as a social-economic force operating in a complex technical field, the industry can maintain vision, all will be well. The day it loses vision will be a sad day for the industry. And, considering the great importance of power and the contributions that private enterprise functioning in power has made and can continue to make to the welfare of the country, it would be a sad day for the country as well.

[6] "Viscosity—Temperature Diagram—Navy Fuel Oils," by G. B. Vroom, second edition, Simmons-Boardman Publishing Corporation, New York. N. Y., 1931.

Design and Application of WASTE-HEAT BOILERS

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THE engineer constantly must seek and devise ways of utilizing the excess energy which must be discharged from every process. The waste-heat boiler is sometimes the instrument best suited to recover some of the excess energy. Often, it will serve a dual purpose; (1) as a means of process control, and (2) as a means of energy conservation. It may be used to control the temperature of an exothermic reaction to maintain a favorable reaction equilibrium. It may serve as a condenser to remove heat of vaporization and it may be used for rapid cooling of a gas, liquid, or a fluidized solid. The waste-heat boiler is a particular type of heat exchanger serving several special purposes and with definite limitations in its application.

TYPES OF BOILERS

The type of boiler best suited to the application must be determined. This involves the physical and chemical characteristics of the hot fluid, steam conditions, and space or configuration requirements to fit the boiler with related equipment. There are two basic types, namely, fire-tube and water-tube boilers. In the fire-tube boiler the hot fluid passes through the inside of the heat-transfer tubes and the shell contains the boiling water. The opposite is true of the water-tube boiler.

Characteristics of the hot fluid which bear on selection of the type boiler include the following:

1 Physical state—gas, vapor, liquid, fluidized solid, pressure, temperature, and density.

2 Properties—viscosity, thermal conductivity, specific heat.

3 Activity—reaction to boiler materials.

4 Contaminants—degree of surface contamination expected as affecting heat transfer and pressure loss.

Steam and water conditions affect the choice of type principally with respect to pressure, means for separating the steam from the water, means for keeping hot surfaces wet, and means for cleaning the water side.

Special tube shapes and extended-surface arrangements are applicable to both types of boilers. Extended surface is applied only to the hot-fluid side where the film rate of heat transfer is considerably lower than the boiling water film rate.

Both of the basic types of boilers may be arranged with tubes vertical, inclined, or horizontal, with due consideration given to natural (gravity) circulation of fluids.

Determining the required surface of heat transfer to obtain the performance desired involves evaluation of the over-all coefficient of heat transfer. For any given fluids and type of surface involved, the factors limiting the heat-transfer coefficient are pressure loss, erosion, and circulation of water. Mass velocity is a parameter common to pressure loss and coefficient of heat transfer.

BOILER ARRANGEMENT

Having selected the type of boiler and the type of surface, a preliminary determination of the surface requirement is made. Next, an arrangement is devised to suit the application giving consideration to all of the factors involved. Simplicity of design, standard methods of manufacture, accessibility for repair and maintenance, and freedom from operating difficulties are the specifications for a good arrangement.

The arrangement devised is then checked for performance and adjusted as required. Pressure parts and connections are designed to meet the requirements. Careful attention is given to allowance for thermal expansion and proper support of all elements. The steam drum is adequately sized and equipped with internals to provide proper separation of steam and water, control of water concentrations, and proper circulation of water through the heating elements. Steam-drum location, downcomer, and riser sizes and arrangements are determined by analysis of the circulation of water and steam through the boiler circuits.

Boiler fittings are selected and properly located. Blowdown connections, cleanouts, access doors, soot blowers, and platform locations are shown. Clearances for element removal are indicated, and if draft fans, dampers, and a stack are required, the performance specifications and recommended arrangement for these are prepared. Next, a material list is prepared, weights are calculated, and a cost estimate is made.

As examples of the two basic types of waste-heat boilers, a simple arrangement will be discussed as well as a more complex example of each to point out how the factors presented influence the designs.

FIRE-TUBE BOILER

A simple horizontal fire-tube boiler is shown in Fig. 1. This design was prepared for application in an ammonia-synthesis process to cool the reformed gas prior to its being compressed for further processing. The steam generated is at low pressure for use in the reforming operation so the boiler application is an economy measure. The gas is clean and noncorrosive to steel. It enters the boiler at 1255 F and at 5 psig.

The relatively low temperature and cleanliness of the gas would indicate that extended surface might be used to advantage. The gas pressure called for a leakproof design. The gas density, pressure, and analysis showed that a high mass velocity could be used and that a relatively high gas-film rate of heat transfer would result. This made the value of extended surface questionable. The low steam pressure and the relatively small gas-passage area required made the fire-tube type seem the most economical. This type is excellent for providing for the gas pressure. Extended surface on the inside of the tubes would result in making these shorter and, since the performance factor required was quite low, it was evident that the unit would be relatively short even with bare tubes. The low steam pressure permitted the steam-separation space to be incorporated in the shell, with the tubes fully submerged for full effectiveness in the horizontal arrangement. Gas connections were located at the sides of the vestibules to provide for tube removal without disturbing the gas ducts. The low

[1] Mem. ASME.

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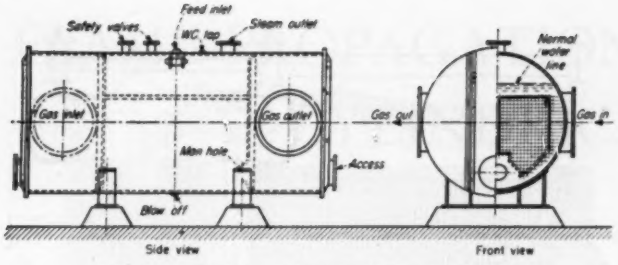


FIG. 1 HORIZONTAL FIRE-TUBE-TYPE WASTE-HEAT BOILER

steam temperature and short length between supports permitted simple cradle supports which could provide for the small thermal expansion.

The principal drawback to this arrangement in this application will be keeping the water side clean. The steam going to process without condensate return calls for careful attention to water control. There is little danger of tube failure from scale formation but performance would be affected.

WATER-TUBE BOILER

Fig. 2 illustrates a common arrangement of the water-tube type employing an upper and a lower drum connected by a bank of vertical bent tubes. This arrangement is used for application to heat recovery from flue gases which are at approximately atmospheric pressure, free of slag-forming contaminants or corrosive products, and for high or low steam pressures and high or moderate gas temperatures. Extended surface may be used under suitable temperature conditions with clean gases. Circulation is good, but, of course, heat-absorption rates are limited. A superheater and an economizer are readily adapted and auxiliary firing may be provided. Gas flow may be parallel to drums or perpendicular to them. By suitable baffle arrangement the flow may be made parallel to the tubes. If the gas is dust-laden, two lower drums are used with dust hoppers located between them. The unit is usually supported at the upper drum with the lower drum suspended by the tubes, permitting free expansion. The steam drum should be of ample proportion to provide steam release. Tubes should all be well submerged at the upper drum and fully drainable to the lower drum. Tube size and arrangement at the drums affect ligament efficiency and drum cost. The steam outlet should be located near the gas-outlet end of the unit with consideration to difference in water level when in operation. Refractory or steel-lined casings are used as temperatures indicate. Outer casings must be insulated fully from the inner linings and sufficient cleanout doors provided. Side casings are removed for tube replacement, and tubes are arranged so that individual tubes may be replaced. Access to the water side is provided through manholes in the drums.

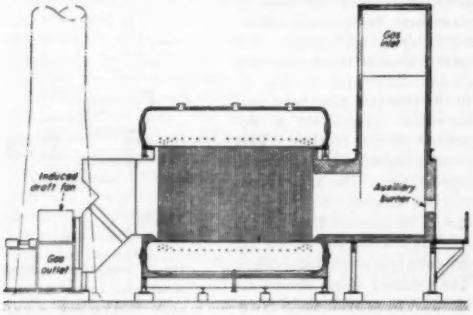


FIG. 2 VERTICAL WATER-TUBE-TYPE WASTE-HEAT BOILER

EXTENDED SURFACE—REVERBERATORY FURNACE

Another water-tube type is shown in Fig. 3. This unit employs extended surface and is arranged with horizontal, hairpin, bent tubes, series-connected in parallel groups through manifold headers to the steam and water drum by riser and down-comer tubes. The extended surface is applied to the tubes in the form of cast-iron gilled rings thermally shrunk on the steel tubes. The cast-iron rings provide a bulwark against gas-side corrosion and more than overcome the added resistance to heat absorption by virtue of the extended surface. The design was developed for application to contact sulphuric-acid plants. The gases are under moderate pressure and contain considerable SO_3, hence the cylindrical shell of leakproof arrangement with horizontal tubes.

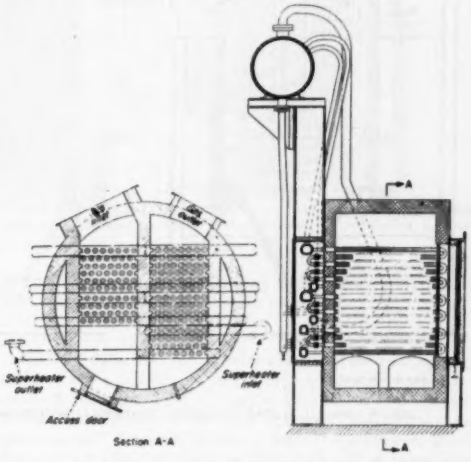


FIG. 3 HORIZONTAL WATER-TUBE-TYPE WASTE-HEAT BOILER WITH EXTENDED SURFACE

Units of this design have received wide acceptance in plants burning brimstone. The gases are kept clean by settling or filtering the molten sulphur before burning. As a rule, continuous operation without shutdown extends for periods of 12 to 18 months.

A similar arrangement of this design is used in the sulphur-recovery process where the gas through the boiler contains sulphur vapor as well as SO_3. In this process the molecular form of the sulphur vapor undergoes changes as the gas is cooled in the boiler. This is an exothermic reaction which must be considered in determining the surface requirement and in providing for proper circulation.

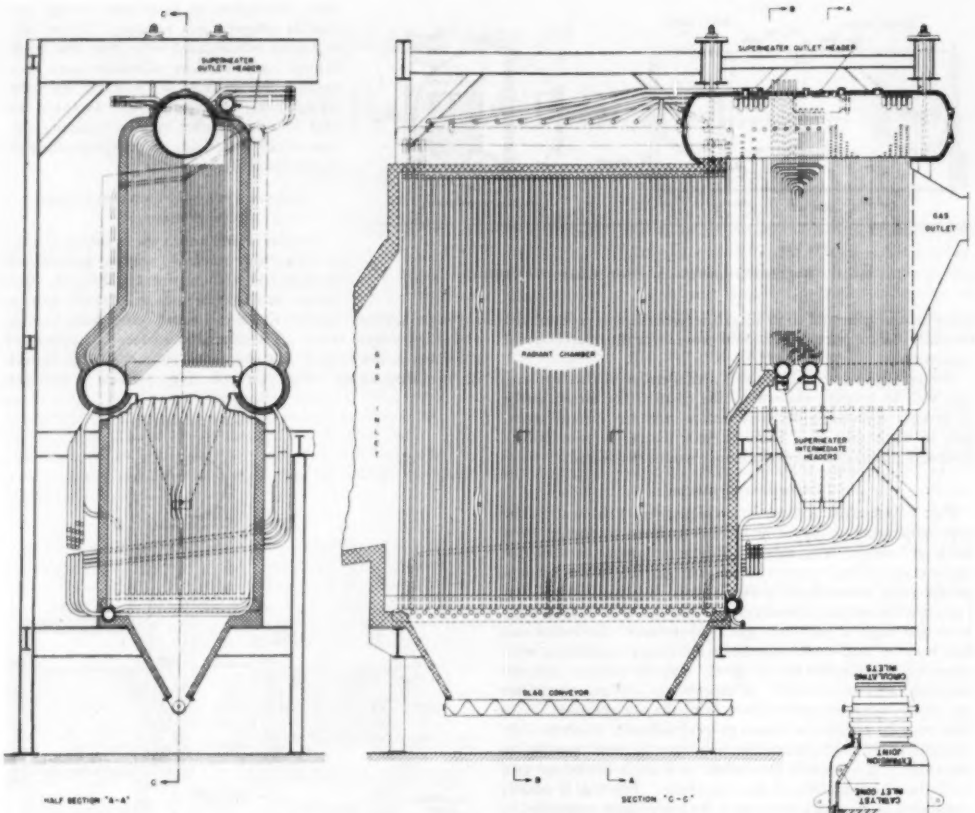


FIG. 4 SPECIAL WATER-TUBE-TYPE WASTE-HEAT BOILER FOR COPPER REVERBERATORY FURNACE

A special arrangement of a water-tube waste-heat boiler is shown in Fig. 4. This unit is applied to a reverberatory furnace in a copper-smelting process. In this instance, the gas comes from a large furnace containing the molten mass of copper and slag. During certain periods in the smelting process, molten slag and metal droplets are carried over by the gas. These would freeze on boiler surfaces if allowed to strike in the molten state. The large radiant chamber is designed to freeze the liquid droplets in suspension and to lower gas velocities so the solidified particles fall out of suspension into the hoppers provided.

Gases enter the radiant chamber at about 2200 F and the convection bank at about 1400 F passing first through a slag screen of tubes.

The convection section uses the three-drum arrangement with hoppers located between the lower drums to collect additional dust which is dropped out in this section. Dust is removed from the hopper by a screw-type conveyer. A large number of soot blowers are provided and these are operated at frequent intervals in sequential order throughout the day. These boilers operate continuously without shutdown for periods of 16 to 18 months.

CATALYST COOLER

The fluid catalytic-cracking process for petroleum refining furnishes several examples of waste-heat boiler and steam-superheater application. Of special interest are the catalyst coolers illustrated in Fig. 5. In the catalytic reaction a carbonaceous by-product is deposited on the catalyst. This coke is burned with air in the regenerator. The regenerated catalyst is made to flow with carrier air upward through the tubes of the coolers which are fire-tube-type waste-heat boilers. The external steam drums are elevated to provide the thermosyphon head for natural circulation.

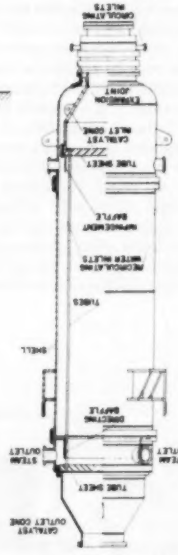


FIG. 5 SPECIAL FIRE-TUBE WASTE-HEAT BOILER CATALYST COOLER FOR FLUID-CATALYTIC-CRACKING UNIT

FLAME PROPAGATION *in* CYLINDRICAL TUBES

By PHILIP LEVINE

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS, LANGLEY FIELD, VA. JUNIOR ASME[1]

AN experimental study of flame characteristics in cylindrical tubes, made in the spring of 1951, indicates that among the factors influencing flame-propagation characteristics are the size, shape, and position of the combustion chamber. This paper includes a discussion of the observations and conclusions resulting from the experiment.

EXPERIMENTAL ARRANGEMENT

The fuel used throughout the experiment was a mixture of propane and air. The fuel was premixed and passed through the tubes at very slow flow rates, so that laminar and incompressible flow was assumed.

Pyrex glass tubing was used, with one end of the tube open, while fuel was admitted through the other end. The tubes were four feet in length, but varied in diameter.

The apparatus setup is shown in Fig. 1. Propane and air entered the apparatus through valves *P* and *A*, respectively. The fuel proportions were obtained by passing the air and propane through two finely calibrated nozzles *N*. Directly across the nozzles were located the manometer leads, *M*. Pressure drops across the nozzles were calibrated by using a wet flowmeter in line with each nozzle.

The air and propane were mixed in a mixing chamber *X* consisting of two screens placed at right angles to the direction of flow. Upon leaving the mixing chamber, provision was made to obtain the temperature *T* of the mixture.

The fuel mixture entered the tube *G* through a small-bore burner, *B*. As the tube became filled, it was ignited, and the flame movement was determined. A meter stick *S* was used to facilitate flame measurements.

Fig. 2 is a detail of the burner used. The burner permitted the fuel mixture to enter the tube; it acted as a flame stopper because of its small throat bore thus preventing the flame from entering the mixing chamber; and it also served as a small surge tank, aiding to maintain uniform flow.

An ordinary motion-picture camera taking 16 frames a second was used to measure the flame speeds. Fig. 3 was obtained with a still camera without the use of artificial lighting but merely using the luminescence of the flame, and overexposing the film considerably.

Very slow mass flow rates were used, with a maximum Reynolds number of 1200. The fuel-air mixture was varied, by holding the air constant and varying the fuel, so that the mass flow rate could be maintained as nearly constant as possible.

As the flame in the tube moves upstream, it accelerates until it attains a uniform movement. The observed flame movement may be used to arrive at the velocity of flame propagation. The velocity of flame propagation is merely the technical designation for the absolute rate of flame movement through a particular medium. The absolute rate of flame movement may be computed by adding the observed rate of movement to the velocity of fresh fuel flowing in the tube (1).[2]

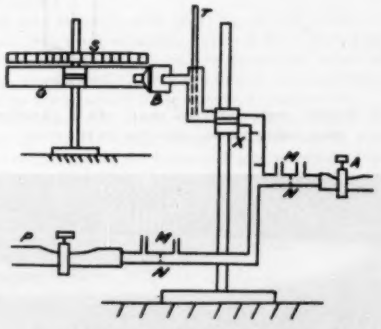


FIG. 1 EXPERIMENTAL APPARATUS SETUP

(*A* and *P* designate air and propane, respectively; *N*, nozzle; *M*, manometer; *X*, mixing chamber; *T*, thermometer; *S*, meter stick; *G*, glass tube; *B*, burner.)

OBSERVATIONS

With the flame area just prior to entry into the tube appearing as a plane surface, one might expect that any further increase in the combustion velocity relative to the fuel velocity would cause the flame to move upstream, maintaining its plane surface. However, the actual flame shape observed was a distorted semielliptical shape, see Fig. 3 and Fig. 4, upper diagram.

The observed shape was not peculiar to this experiment alone, but has been previously observed by other scientific investigators (2). An explanation for the consistently distorted shape may be as follows:

Propane burns at approximately 2250 R while the fresh fuel is at a temperature of 530 R. The temperature ratio of the exhaust gases to the fresh gases is approximately four to one. Consequently, expansion of the fresh fuel mixture will occur as it passes through the flame front, with the specific volume of the exhaust gases being approximately four times the specific volume of the fuel mixture. The exhaust gases are restricted to travel within the same tube, and a rise in velocity of the exhaust products will be necessary to maintain equilibrium between the mass of fuel consumed and the mass flow of exhausted products. The continuity equation dictates that the velocity of the exhaust gases will increase at the same rate as the specific volume. Average velocities are referred to and laminar and incompressible flow has been assumed. Further, the temperatures referred to were not measured values, as the flame tem-

[1] Formerly, mechanical engineering student, University of Connecticut, Storrs, Conn.

1951 Undergraduate Student Award paper. Presented at the 1951 ASME Region I Student Conference, April 20-21, 1951, at the University of Vermont, Burlington, Vt. Condensed.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

peratures depend upon the mixture proportions, heat transfer, diluents, and completeness of mixing. Further, the temperatures referred to could not exist uniformly across the tube area, due to heat transfer from the walls, convection currents, and stratification of the fuel mixture. However, the discussion is

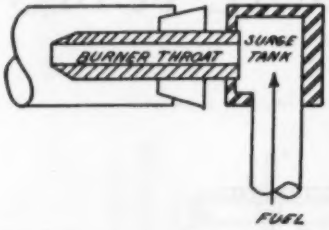


FIG. 2 BURNER USED, SHOWING SMALL SURGE CHAMBER, AND SMALL-BORE THROAT RELATIVE TO THE TUBE

FIG. 3 ACTUAL PHOTOGRAPH OF FLAME FRONT IN TUBE SHOWING ELONGATION

being limited to a qualitative aspect, and the assumed temperatures may be considered to be average values.

With an increase in velocity approximately four times, there is a resultant change in momentum, which would cause a pressure to exist on the flame, thereby propelling the flame upstream. The pressure acting over the flame may not be uniform and may act to distort the flame surface.

The velocity of the exhaust gases would have to increase as a result of chemical combination alone. Consider the chemical equation for combustion of propane $C_3H_8 + 5O_2 + 18.8N_2 \rightarrow 3CO_2 + 4H_2O + 18.8N_2$.

Note that there are a greater number of moles of products than there are moles of charge. Therefore to maintain the constant mass flow rate within the tube the exhaust velocity must rise further.

Consider the effect from temperature alone. The large thermal gradient across the flame front is sufficient to induce rapid convection currents that would further serve to distort the flame pattern.

In Fig. 4 the center diagram illustrates the velocity profile of the exhaust gases due to friction along the tubes' walls. The parabolic distribution of the velocity pattern means that there are greater mass flow rates of products existing near the tube center than near the tube walls. As a result of the larger velocities existing nearer the tube's center, the burning front would have to maintain a similar distribution, but in the opposite sense to maintain equilibrium between the mass of fuel being consumed and the mass of exhaust products flowing.

The parabolic distribution of flow is not limited to the exhaust gases, but also exists in the fresh fuel. It appears that the summation of all these factors—temperature gradients within the tube, velocity gradients within the tube, circulation, and friction, result in a distorted flame surface.

The theory that gravity distorts the flame surface was discounted as the same flame shape was observed within the tube in vertical or horizontal positions (3).

The length of the flame was also observed to vary with increasing flame speeds. The flame length was also found to vary with tube diameter.

MEASUREMENTS

It is possible to determine the combustion velocity from the observed rate of flame movement. In Fig. 4 the vectors V_r and V_n designate the velocity of flame propagation and combustion, respectively. The velocity of combustion is acting normal to the flame surface. The velocity of flame propagation is acting axially along the tube and across the tube's cross-sectional area. Therefore it appears that these two velocities may be related, by relating their respective areas, as incompressible flow has been assumed. Fig. 5 illustrates, through analogy, how the velocity of flame propagation is related to the velocity of combustion. It is shown that the velocities of fluids in incompres-

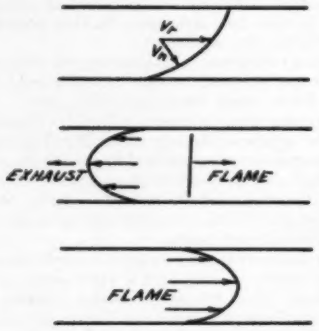


FIG. 4 FLAME-SHAPE DETAIL

(Upper diagram illustrates actual flame shape observed. Center diagram shows the velocity profile of the exhaust gases and emphasizes the incompatibility of the exhaust profile with a plane burning surface. Lower diagram shows a flame velocity profile one might expect due to the parabolic exhaust profile.)

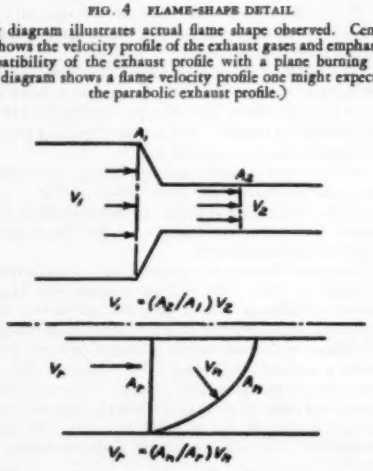


FIG. 5 INCOMPRESSIBLE-FLOW ANALOGY ILLUSTRATES HOW THE VELOCITIES OF FLAME PROPAGATION AND COMBUSTION MAY BE RELATED THROUGH THEIR RESPECTIVE AREAS

sible flow vary as the inverse ratio of the areas over which they are acting.

Essentially, the same problem exists in the tube as in flow of an incompressible fluid in pipes of varying diameter. The velocity of flame propagation is acting over the cross-sectional area of the tube, while the velocity of combustion is acting over the flame surface. As a result, these two velocities are related as the inverse ratio of their respective areas, see Fig. 5, lower diagram.

The major problem in determining the combustion velocity lies in the determination of the flame surface area. This was done through photography. The flame velocities in tubes were found to be at least twice the combustion velocities, due to the elongation and distortion of the flame surface.

RESULTS

Fig. 6 is a plot of velocity versus air-fuel ratio of the fuel. The air-fuel ratio is on a mass basis. The dotted vertical line at an air-fuel ratio of 15.7 to 1, is the stoichiometric mixture. The upper curve is a representative plot of flame propagation velocity versus air-fuel ratio. Note that the maximum flame velocity occurs at a mixture that is richer than stoichiometric. This

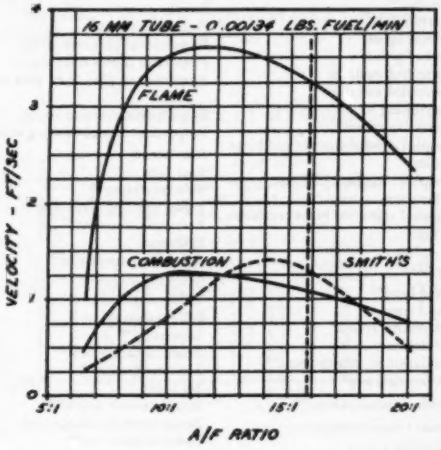


FIG. 6 EFFECT OF AIR-FUEL RATIO ON FLAMES AND COMBUSTION VELOCITIES

was probably due to the necessity of having an excess of energy above the ideal chemical requirements supplied to the combustion process to account for heat-transfer losses, impurities, and incomplete combustion. It was noted that by increasing tube diameters leaner mixtures were possible. This leads one to suspect that the walls of the tube have a further deactivating effect as put forth by the "chain-reaction" theory of combustion (4).

According to Fig. 6 there are definite limits of mixture proportions beyond which the mixture will not support flame propagation in the tube. The lean-limit ratio appears as 20.1 to 1, and the rich-limit ratio 6.8 to 1. At these limits the flame velocities were very low and the flames became less intense.

Below the flame propagation curve in Fig. 6 is plotted the combustion-velocity curve. The combustion curve appears much flatter and lower than the flame-velocity curve, because each point on the combustion curve was obtained by dividing the point on the flame-velocity curve directly above it by the inverse ratio of the respective areas over which these two velocities are acting. The combustion velocity is acting over a considerably larger area than the flame velocity, see Fig. 3, due to the flame surface distortion. The combustion velocity curve is flatter than the flame velocity curve due to the elongation of the flame surface as flame velocities increase. The velocity of the combustion curve has the same critical limits of fuel-air ratios as the curve was determined entirely from the flame-propagation curve above it. The dotted line represents a curve obtained by a previous experimenter, F. A. Smith (5). This curve falls closer to the stoichiometric value than the author's. The nature of Smith's apparatus and technique may have been different from the author's which would result in some variation of results.

Three tube diameters were used: 12, 16, and 22 mm. It was observed that flame velocities increased with increasing tube diameter. Reasons for this may be the reduced effect of heat transfer, the reduced effect of the tube walls deactivating the combustion process, and the greater flame surface area.

By increasing tube diameters, the relative effects of heat transfer by the tube's walls decrease, as the ratio of wall area to tube volume rapidly decreases with increasing tube diameter. In general, with tubes of larger diameters, the volume of gas burning is greater, and the combustion process is less susceptible to exterior influences.

Fig. 7 shows the effects of tube position on the maximum flame velocities observed for the same fuel flow. It was found that the maximum flame velocity occurred with the tube in a vertical position and the flame traveling upward. The slowest velocities were observed with the flame traveling downward in a vertical tube. Intermediate velocities were noted in horizontal tubes.

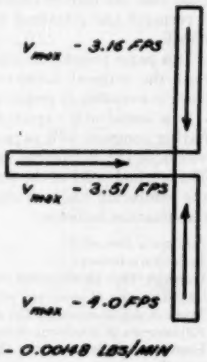


FIG. 7 EFFECT OF TUBE POSITION SHOWING MAXIMUM FLAME VELOCITIES WITH THE TUBE IN A VERTICAL POSITION AND THE FLAME MOVING UPWARD

Flame velocities may be greater when the flame moves upward due to a heat-transfer effect, whereby the fuel is preheated by rising convection currents from the flame front. The preheated fuel requires less energy for combustion, and permits combustion to occur more easily. With the flame traveling downward, there is little effect of the convection currents preheating the fresh fuel before combustion. The shape of the flame front remained the same regardless of position.

CONCLUSIONS

The results of the experimentation substantiate many theories and practices in the field of combustion.

Consider the effect of the air-fuel ratio upon flame propagation. The knowledge that limits do exist, where no flame can propagate, has permitted automotive engineers to design combustion chambers that retard detonation, by making the last bit of charge in the cylinder excessively rich or lean (SI engines).

(Continued on page 489)

AUTOMATIC-CONTROL TERMINOLOGY[1]

A Review of Earlier Definitions Compiled by the Committee on Terminology of Industrial Instruments and Regulators Division, ASME

THE need for a common language in the field of industrial process control was recognized when in February, 1946,[2] the Terminology Committee of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers published its list of terms and definitions. These were the result of an earlier publication appearing in 1944.[3] Normal evolution requires that such terminology be revised in accordance with usage and changes in the technology. Growth in recent years of interest in this field, together with activity in related fields, has accelerated need for a revision of the original terminology. This process, of course, will continue as the technique of related fields approaches more nearly that of the process-control engineer. It is with this thought in mind that the current revision of the automatic-control terms is prepared and submitted for comment to the membership of ASME.

This paper presents in condensed form the scope of the work since the original definitions were prepared. The complete work is available in preprint form.[1]

It is confidently expected that this approach will provoke further comment and suggestions, thus permitting further revision of the definitions and result in their standardization. The original order of the definitions has been preserved though the numbering has been changed in a few cases. The present classification includes:

Automatic controllers
Basic characteristics
Processes, their elements and characteristics
Characteristics of automatic control
Types of automatic-controller action
Adjustments of automatic-controller action
Elements and characteristics of automatic controllers
Basic terms
Block diagrams and symbols
Automatic-control combinations

The original terms have been modified only slightly. A notable contribution to the original definitions is the inclusion of suitable illustrative diagrams which materially assist in gaining an understanding of the definition. The preparation of these illustrative diagrams is largely based on the work of J. G. Horn,[4] and from which the material was freely used. The following tabulation of the complete new list indicates definitions which have been modified and those which have been added:

Accuracy in measurement**
Actuating signal**
Automatic controller*
Automatic-control system**
Average-position action
Calculating action**
Capacitance
Capacity*
Cascade combination**
Combination automatic controller**
Command**
Control agent
Control point*
Controlled medium
Controlled variable
Controlling means
Corrective action*
Coupled control-element combination**
Coupled feedback-element combination
Coupled reference input combination
Coupling
Cycling*
Dead band**
Dead time
Derivative action
Deviation
Deviation in measurement**
Differential gap*
Error in measurement**
Final control element
Floating action
Floating average-position action
Floating rate
Floating speed
Integral action*
Manipulated variable
Measuring means*
Motor operator*
Multiple action
Multiposition action
Multispeed floating action*
Neutral zone*
Offset*
Parallel cascade action**
Positioning action
Precision in measurement**
Primary element
Primary feedback**
Process
Proportional band
Proportional plus rate action
Proportional plus reset action
Proportional plus reset plus rate action
Proportional position action
Proportional speed-floating action
Rate action
Rate time
Reference input**
Relay-operated controller
Reset rate
Resistance
Resolution sensitivity**
Sampling action**
Self-operated controller
Self-regulation
Sensitivity**
Series cascade action**
Servomechanism**
Set point
Single cascade action**
Single-speed floating action
Summation action**
Threshold sensitivity**
Two-position action
Two-position differential-gap action
Two-position single-point action

*Definitions changed.
**Definitions added.

Recognition has been made also of the relation in industrial process control of the concepts developed by the AIEE Committee on Feedback-Control Systems.[5] Liaison with this committee has been maintained to obtain uniformity on common terms. The use of the block diagram and a common symbolism is recognized, and the proposed AIEE terms and symbols have been adopted where they apply. Wherever block diagrams are used the proposed symbols and feedback designations are those recommended by the AIEE Committee. The compatibility with automatic process-control systems will be immediately apparent, and the adoption of this common language is highly recommended.

[1] Compiled by Committee on Terminology of Industrial Instruments and Regulators Division, ASME. The complete paper, No. 52—SA-29, "Automatic-Control Terminology," by Marc A. Princi, will be presented at the ASME Semi-Annual Meeting, Cincinnati, Ohio, June 15–19, 1952.

[2] "Automatic-Control Terms," MECHANICAL ENGINEERING, vol. 68, February, 1946, pp. 134–138.

[3] "Process Control Terms," MECHANICAL ENGINEERING, vol. 66, March, 1944, pp. 205–206.

[4] "Graphic Representation and Analysis of Automatic-Control Terminology," by J. G. Horn, Brown Instrument Co., presented at the 1946 Annual Meeting of the ASME.

[5] "Proposed Symbols and Terms for Feedback Control Symbols in AIEE," *Electrical Engineering*, vol. 70, 1951, pp. 905–909.

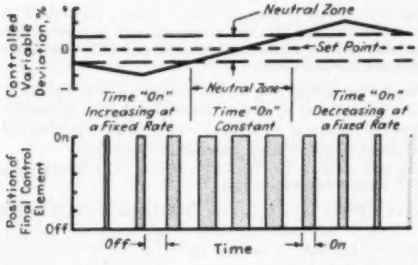
The continuing effort of the work of the Terminology Committee, since its publication in February, 1946, of a set of definitions for automatic-control terms, has resulted in a revision and explanation of the scope of the definitions originally prepared. This new work is broadened to include the concepts common in the field of feedback control systems as they apply in industrial process control. In addition, recognition has been made of the need for definition of automatic-control combinations. The material as presented here should go a long way toward the evolution of a common language in the broad field of automatic control.

Definitions of basic measurement terms are included because of their value in achieving a better understanding of automatic control. Accuracy, precision, and error are here defined as they apply in automatic control. The definitions are consistent with those already standardized by the American Standards Association. The value of reliable definitions of these terms will be immediately recognized. Control combinations are extensively applied in industry. A comprehensive treatment of all possible combinations was determined impractical; however, the basic forms will be found under the general headings of *cascade combination*, both series and parallel, and *combinations employed for summation* or other *calculations*. It is believed that these basic groupings define the more common systems and provide for an understanding of others.

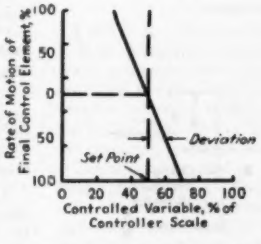
Another ASME Committee has prepared a glossary of nuclear terms[8] which includes a portion of the terms submitted by this Committee. The general agreement being approached in the definition of terms is reassuring. All groups concerned with various aspects of automatic control are achieving a more common language. This effort on the part of the Industrial Instrument and Regulators Division of the ASME is another step in that direction and represents a real contribution. It is the desire of this Committee to receive serious criticism of this work in order that a pamphlet, similar to that published in 1947, can be reissued to include these revised terms modified as recommended by the broader membership. It is suggested that October 1, 1952, be established as a deadline for submitting comments. This will provide for an early publication of the pamphlet which will be broadly distributed.

Valuable criticism and contributions have been received from many members of the Industrial Instruments and Regulators Committee of the ASME, as well as the co-operative efforts of the British Standards Institution, who have supplied us drafts of their proposed terms. The Committee extends its thanks to these and others who have so generously contributed.

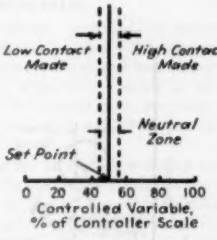
Examples of Revised Terms Showing Illustrative Diagrams



FLOATING AVERAGE-POSITION ACTION, SINGLE-SPEED TYPE



PROPORTIONAL-SPEED FLOATING ACTION



SINGLE-SPEED FLOATING ACTION WITH NEUTRAL ZONE

Integral Action is that in which the final control element is positioned in accordance with a time integral function of the controlled variable.

Floating action is the most common form of integral action.

Floating Action is that in which there is a predetermined relation between the deviation and the rate of motion of a final control element.

A neutral zone, in which no motion of the final control element occurs, is often employed in floating controller action.

Single-Speed Floating Action is that in which a final control element is moved at a single rate.

Multispeed Floating Action is that in which a final control element is moved at two or more rates, each corresponding to a definite range of values of deviation.

Proportional-Speed Floating Action is that in which the position of the final control element is changed at a rate proportional to the deviation.

Floating Average-Position Action is that in which there is predetermined relation between deviation (of the controlled variable) and rate of change of the time-average position of a final control element which is moved periodically from one of two fixed positions to the other.

Offset is the steady-state difference between the control point and the value of the controlled variable corresponding with the set point.

Offset is an inherent characteristic of positioning controller action.

Capacity is a measure of the maximum quantity of energy or material which can be stored within the confines of a stated piece of equipment. It is measured in units of quantity.

The volume capacity of an open tank, for example, is the maximum volume of liquid it will hold without overflowing. The weight capacity of a compressed-air tank is the maximum weight of air which it will hold without exceeding safe pressure.

[8] "A Glossary of Terms in Nuclear Science and Technology" now in preparation.

Basic Terms in Measurement

Accuracy in Measurement is the degree of correctness with which a measuring means yields the "true" value of a measured quantity.

The "true" value refers to accepted engineering standards, such as the standard meter, gram, etc. It is assumed that a true value always exists even though it may be impossible to determine.

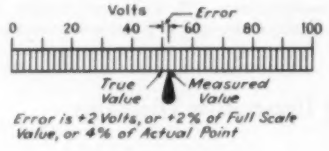
Precision in Measurement is the degree of reproducibility among several independent measurements of the same true value under specified conditions.

It is usually expressed in terms of deviation in measurement.

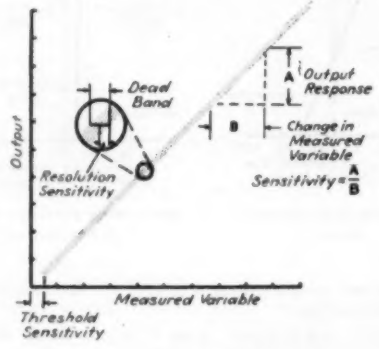
Error in Measurement is the algebraic difference between a value which results from measurement and the corresponding true value.

A positive error denotes that the measured value is algebraically greater than the true value. Error is usually expressed in the units of the measured quantity, or as a fraction (or per cent) of the full scale value, or of the actual value.

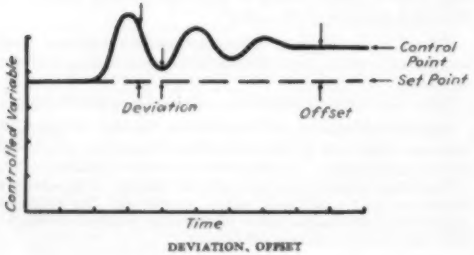
Deviation in Measurement is a statistical number representing the randomness among independent measurements of the same true value.



ERROR IN MEASUREMENT



SENSITIVITY, DEAD BAND



DEVIATION, OFFSET

Deviation is variously expressed as: (*a*) the difference between any measurement and the mean value of two or more; (*b*) the average of several independent variations from the mean (the Average Deviation); (*c*) the root-mean-square value computed from several individual deviations (this is the Standard Deviation); or (*d*) the ratio of (*a*) or (*b*) or (*c*) to the mean. In any case the number of observations should be stated.

Sensitivity is the ratio of output response to a specified change in the measured variable.

For example, an automatic-temperature controller having a net output pressure of 15 psi and a full scale range of 0 to 150 F would have a sensitivity of 0.1 psi per deg F.

Where nonlinear relationships are involved the point or points at which the sensitivity is given should be stated.

Resolution Sensitivity is the minimum change in the measured variable which produces an effective response of the instrument or automatic controller.

Resolution sensitivity may be expressed in units of the measured variable or as a fraction or per cent of the full scale value, or the actual value.

Threshold Sensitivity is the lowest level of the measured variable which produces effective response of the instrument or automatic controller.

Dead Band is the range of values through which the measured variable can be varied without initiating effective response.

Automatic-Control Combinations

A Combination Automatic Controller is more than one closed loop connected in combination, the loops being coupled through primary feedback or any of the controller elements.

The distinction should be carefully made between a plurality of independent automatic controllers *with no coupling except for secondary feedback disturbances* and a combination automatic controller *with definite coupling between two or more loops*.

Coupling is that connecting means through which signals or actions directly related to two or more closed loop automatic controllers are combined to achieve a control function beyond the capabilities of independent automatic controllers.

Coupling may occur as (*a*) feedback coupling (*b*) reference input coupling (*c*) control-element coupling.

A Coupled Reference Input or Cascade Combination is one in which control output or feedback signals from one automatic controller are used to regulate or *readjust* the set point or modify the reference input signal of one or more other automatic controllers.

Single Cascade Action is the regulation of the set point on one automatic controller by the action of another automatic controller.

Time program control does not constitute a closed loop unless time is affected by feedback.

Parallel Cascade Action is the regulation of the set points of two or more automatic controllers by the action of one other automatic controller.

Series Cascade Action is the regulation of the set point of each of a number of automatic controllers by the action of the preceding automatic controller in the series.

A Coupled Feedback-Element Combination is one in which the primary feedback to an automatic controller is a function of the primary feedback or control output (actuating signal) from one or more other automatic controllers as well as from its own measuring means.

Summation Action is the coupling of one automatic-controller primary feedback with another or with other automatic-controller actuating signals to function as the algebraic sum of the combination.

Special cases are Cutback, Limiting, Overriding, and certain types of Proportioning Action.

Calculating Action is the coupling of primary feedbacks with one another and/or any other actuating signal(s) to follow any computable function of the combination.

Typical cases are Ratio Action, Multiplication Action.

A Coupled Control-Element Combination is one in which two or more actuating signals or control element actions are combined to operate one controlling means.

What Are the Opportunities in Engineering and Science?

(*Continued from page 474*)

agencies. The maintenance of a continued and adequate supply of qualified engineers depends upon the ability, personality, and competence of teachers furnished by the engineering profession.

One of our Kodak engineers recently returned from a trip to several of the engineering colleges to interview members of the 1952 class relative to employment. He states that many of these young men have received a dozen or more offers. ROTC members are in many cases employed by industrial firms who are quite willing to take the risk of temporary loss of such men to the Armed Services. A portion of this frantic rush at the moment is due to the demands of defense production, but in the main it reflects the ever-increasing technological demands of American business and industry. The great increase in labor rates in the past few years have made continued advance in mechanization essential to survival in a competitive system. As manufactured articles come within reach of more and more people, sales and employment have increased. New discoveries and inventions increase rapidly, and their demands upon the scientist and engineer are exceptional.

It is this expanding economy of ever-increasing productivity that is America's pride and America's hope for the future. Within the life span of many of us here the normal work week has been almost cut in half considering hours of work, vacations, holidays, and the like. The backbreaking tasks have been largely absorbed by mechanization. For much of this the engineer is responsible. He should aspire to preserve this way of life through which the material comforts and conveniences provided by a system of free enterprise may be made available to more and more of the world's people. In such a world the engineering profession will face challenge—and opportunity—as never before.

Flame Propagation in Cylindrical Tubes

(*Continued from page 485*)

Another application of combustion-chamber design that was substantiated by the experiment is the can-type burner for jet aircraft. One of the limitations placed upon aircraft combustion chambers is that of space. It was seen that flame lengths increased with tube diameters. Thus using a small-diameter combustion chamber decreases the flame length, and permits shorter over-all lengths of jet power plants.

Flame velocity appears to be a governing factor in automotive-engine performance. Combustion requires time, and the typical automotive engine in use today operates at speeds that permit extremely short combustion periods. The maximum flame-propagation velocities attainable are also a limiting factor in high-speed propulsive systems such as the athodyd, where flame velocities of the order of 1000 fps are desired to operate the systems at really high velocities (Mach 2).

It can be seen that there is definite need for a better understanding of the nature of flame movement. Perhaps the future may see higher flame velocities through fuel ionizing before combustion, fuel activation by catalysts, or by merely varying the combustion-chamber design.

ACKNOWLEDGMENTS

The author wishes to acknowledge the co-operation received from the Mechanical Engineering Department of the University of Connecticut throughout the entire experiment; to Prof. David A. Fisher of the Mechanical Engineering Department for his suggestions and guidance; and to the following fellow students who worked with the author: Robert A. Lapuk, David Levine, and Frank Vichi.

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A NEW metallurgical development, produced by Government-supported research, makes possible better manufacturing techniques for the electronic industries and better cutting tools for metalworking shops. This development, a novel brazing technique, is described in a report now available to the public, the Office of Technical Services, U. S. Department of Commerce, announced recently.

The report, prepared by scientists at M.I.T. working on a joint Signal Corps-Air Force-Navy project, summarizes the results of a series of experiments on the brazing of both metals and nonmetallic materials with active metals such as titanium, zirconium, columbium, and tantalum. This brazing technique has been carried out in controlled atmospheres and vacuum with the use of fluxes. The experiments described are of an exploratory nature, with little emphasis on the development of techniques for special applications. The method has been used in brazing a wide variety of materials, i.e., diamonds sapphires, carbides, various ceramics, refractory oxides, glass, quartz, stainless steel, and chrome-iron-type alloys. The active metals used in this brazing technique have the interesting property of wetting both metals and nonmetallic materials equally well, producing exceptionally strong bonds which in many cases exceed the strength of the nonmetallic materials.

Good vacuum seals with glass and ceramic have been prepared by this method. Through the use of brazed ceramics in place of glass, higher bakeout temperatures can be achieved, allowing more rapid outgassing of vacuum apparatus. The applications are not, however, limited to vacuum techniques, but should be useful in the preparation of tools or other devices for which nonmetallic materials are bonded to metal.

PB 106 109, "Metal to Nonmetallic Brazing," 20 pages, including diagrams and tables, sells for $2 in microfilm, $3.75 in photostat. Order should be addressed to the Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D. C., accompanied by check or money order.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Industrial Expansion

THE expansion program which American industry has launched as a part of defense mobilization is now in full swing, according to the fifth and final quarterly report to the President by Charles E. Wilson, former Director of Defense Mobilization. During the six months ending March 31, 1952, industrial plants have been going up and equipment installed at an all-time record rate—in terms of both money invested and physical volume.

The record-breaking rate of expansion extends over virtually the whole of the industrial economy. Investment in manufacturing during this six month period is estimated at 28 per cent above the 1947–1949 rate, utilities 28 per cent above, and transportation 16 per cent above, after adjustment for price changes.

From the standpoint of defense mobilization, said Mr. Wilson, this tremendous expansion program has two purposes. First, it will provide us with a productive capacity sufficient to support the present program of military production and still permit a satisfactory and rising level of production for civilian needs. Second, it will provide a stronger industrial base in the event a greater mobilization effort becomes necessary.

To guide the Government programs of assistance to industrial expansion, definite goals have been established for many key industries, to be reached by 1955 or earlier.

PETROLEUM EXPANSION PROGRAM

New and higher goals have been set for the petroleum expansion program, with the aim of restoring reserve petroleum capacity to safer levels by 1953, Mr. Wilson pointed out.

Since Korea, the demand for petroleum products has increased much more rapidly than the industry's ability to supply oil. As a result, the present reserve capacities of existing oil wells, refineries, and transportation facilities are all below the reserve levels that were available to meet the extraordinary demands that followed the outbreak of World War II. This is true even though the domestic oil industry has increased its capacity by about 50 per cent since 1941.

Even with the further addition of facilities under the new goals, an all-out war would require sharp reductions in the less essential uses of petroleum products.

The rate of oil and gas-well drilling in the United States is to be stepped up substantially; the goal for the latter half of 1952 has been set at 25,000 wells, and for 1953, at 55,000 wells, provided that the necessary pipe can be manufactured by the steel industry. This should raise domestic crude-oil producibility (that is, the ability to produce crude oil at maximum efficient rates of production) by about 9 per cent between July 1, 1952, and the end of 1953.

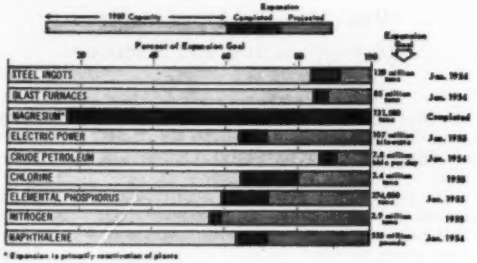

FIG. 1 CAPACITY GOALS GUIDE INDUSTRIAL EXPANSION

Construction of domestic facilities to refine 750,000 bbl of oil daily is to be undertaken during the latter half of 1952 and in 1953, adding about 7 per cent to existing capacity. New oil-storage tanks to be built during the same period should add about 14 per cent to existing storage capacity.

The petroleum industry abroad also has to meet a rapidly growing demand for oil which must be supplied if foreign nations are to carry out their part in the Mutual Security Program. Accordingly, the petroleum program includes plans to make available to export from the United States necessary materials and special equipment to complement supplies obtained from foreign sources.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

The bulk of such materials is destined to other Western Hemisphere countries, with lesser quantities for the oil-producing areas of Indonesia and the Middle East and for refineries in various parts of the Eastern Hemisphere.

POWER EXPANSION

An expansion goal of 32 million kw of new generating capacity for the 3-year period 1952–1954 has been established to meet the rapidly increasing demands of the defense program and at the same time maintain an adequate supply of electric power for civilian uses.

When the addition is completed, the nation's total generating capacity will be more than 107 million kw, as compared with about 68 million kw at the close of 1950. This new objective is slightly higher than that previously used as a guide.

The goal calls for successive expansions of 9 million kw in 1952, 11 million in 1953, and 12 million in 1954. This succession of record annual additions, together with the 7 million kw expansion in 1951 (which was the largest increase made in any one year in the history of the industry), will result in a total capacity 57 per cent larger than that existing at the end of 1950.

Growth in demand this year is expected to match the planned capacity addition. Therefore little or no improvement in generating reserve can be expected.

STEEL EXPANSION

About 9 million tons of new steel-ingot capacity are scheduled to be added this year to the current capacity of 109 million tons. Thus the steel industry will nearly achieve the capacity goal of 120 million ingot tons by 1953.

Almost all types of capacity in the industry are being enlarged, including open-hearth furnaces, blast furnaces, coke ovens, and ore-mining and beneficiation facilities to support the increased open-hearth capacity.

The shortage of steel scrap, which resulted in the closing of eight open-hearth furnaces for short periods during the winter and delay in opening one new furnace, has now eased, at least temporarily.

The decisive factor which caused the recent improvement appears to have been the order which directed auto-wrecking yards to release by April 1 certain types of scrap—cars built before 1946 and all cars stripped of salvageable parts—if they desired to continue to receive cars after that date. NPA orders also moved scrap from mills with relatively plentiful supply to those with critically short supply.

During the past year, in addition, the scrap drives that have been conducted throughout the country have increased the availability of scrap by perhaps 5 to 6 million tons.

Despite the improvement, however, inventories are still at levels much lower than were normal prior to the emergency.

IRON-ORE SUPPLIES

The development of new sources of iron ore, now greatly accelerated, will become more marked each year. Venezuelan production in 1952 is expected to be more than a million tons, or double that of 1951. The first production from the Quebec-Labrador deposits is expected in 1954. By 1956 an estimated 17 per cent of our total supply will be imported.

The need to develop a secure shipping route from the Quebec-Labrador area gives urgency to legislation authorizing development of the St. Lawrence Seaway, now pending in the Congress, Mr. Wilson said.

To supplement the supply of high-grade iron ore needed for our growing steel industry, a capacity goal for processing of taconite—a very hard iron-bearing rock—has been set at an output of 15 million gross tons of iron concentrate annually by the beginning of 1956. To obtain this amount, 45 million tons of taconite will have to be processed. Since reserves of taconite are regarded as practically inexhaustible, their use is expected to be an important factor in making up for the anticipated decline in high-grade shipping ore from the Mesabi range of Minnesota.

ALUMINUM CAPACITY

Under the Government-sponsored expansion program, the aluminum industry is scheduled to add 415,000 short tons of primary capacity in 1952 to the 50,000 tons previously added since the Korean invasion. During 1953 another 197,500 tons is planned, bringing total capacity to 1.5 million tons.

During the quarter just ended the first production came from the additional facilities at Point Comfort, Texas, as well as additional production from the Chalmette, La., plant. Additional facilities at these plants, as well as lines at San Patricio, Texas, and Wenatchee, Wash., will start production soon.

Primary aluminum production in 1952 is expected to total about 1,030,000 tons, compared with 836,000 tons in 1951.

We are scheduled to receive 16,500 tons of Canadian aluminum during the remainder of 1952, under the United States-United Kingdom metals agreement, Mr. Wilson reported. This is in addition to the 11,000 tons received during the past 6 months.

The defense agencies are at present considering and discussing with various interested groups the question of whether arrangements should be made for a further supply of aluminum beyond the present authorized expansion programs.

CHEMICAL OUTPUT

Plans of the chemical industry call for a capital outlay of almost $1.5 billion during 1952, of which about 78 per cent will go into expanding capacity. When these projected plants are completed, the nation's chemical capacity will be up nearly 12 per cent over 1951 and will be 2.5 times the 1939 level.

Among the individual chemicals, the greatest emphasis on new capacity has been for such basic materials as chlorine, ammonia, benzene, phenol, and acetylene products. Some of the earlier programs, such as benzene, are already showing results.

The expansion of nitrogen facilities is under way, with a goal of 2.9 million tons of nitrogen for the 1954–1955 agricultural year compared with 1.6 million tons produced in the 1950–1951 year. The increase will provide a 70 per cent increase in nitrogen for fertilizer by 1954–1955. The reactivated Morgantown, W. Va., Ordnance plant will account for about 160,000 tons of the additional capacity.

TRANSPORTATION FACILITIES

To meet anticipated increases in transportation requirements of the mobilization program, the country's transportation system is being moderately expanded.

The freight-car fleet is expected to increase by approximately 30,000 cars during 1952, to a total of about 2,075,000 by the

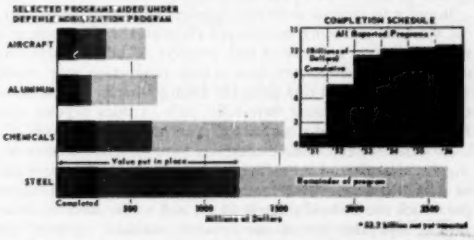

FIG. 2 CONSTRUCTION OF NEW CAPACITY NEARS HALFWAY POINT

year's end. This is expected to be accomplished through output of 90,000 new freight cars of all types and through holding retirement of old cars to a minimum.

Nearly 2000 new Diesel locomotives are being added this year to the 12,300 owned by the railroads in January. As 3800 old steam locomotives are being retired, the total tractive effort available at the end of 1952 will be reduced by a net 3 per cent. However, the majority of existing steam locomotives are obsolete and need to be replaced with modern motive power.

To help carry the steadily increased volume of highway traffic, more than 12,000 miles of new highways are under way with Federal aid. An additional 4700 miles of new construction and 12,000 miles of highway rehabilitation have been programmed. This is supplemented by construction financed wholly by state and local governments.

Construction of merchant ships in United States yards will continue at an active rate during 1952, after which, based on present indications, the workload will drop. Tankers now under construction or on order in American shipyards total 52, of which half are for United States and half for foreign registry. Government funds are providing for the construction of 35 large, fast, dry-cargo vessels of the Mariner class, the first of which was launched on February 29, 1952.

A total of 12 million tons of annual carrying capacity, or 6 per cent, is being added to the Great Lakes fleet. Fourteen new ore carriers are under construction, of which nine are expected to be completed before the end of the 1952 navigation season. These, together with the conversion and repowering of other vessels, should add an estimated $6^1/_2$ million tons lifting capacity on the Great Lakes this year.

VITAL MATERIALS

Mr. Wilson indicated that the programs which have been launched to increase our supplies of scarce materials have now progressed to the point where we can feel assured that the needs for some materials, as now foreseen, will be met by 1953 and 1954, and for most by 1955.

Among the key materials where supply goals should be met by those dates are copper, lead, zinc, and fluorspar.

On a few materials, particularly some of the scarcer metals important to military production, expansion projects under way are not yet fully adequate to meet all of the needs that would arise in the event of all-out war.

New deposits and high-cost mines—which would be unable to operate otherwise—are being brought into production through guaranteed price commitments, purchase-and-resale contracts, direct loans, loan guarantees, and tax amortization.

By 1955 the domestic production of copper is to be expanded by 200,000 tons a year through the use of purchase agreements, loans, and accelerated tax amortization.

Encouraged by the Government's guaranteed floor price of $63 a short ton, domestic production of tungsten in 1951 increased to 6167 tons, 45 per cent over the 1950 level.

In order to increase domestic supplies, explorations for critical minerals are being encouraged through the Government's sharing the cost and risk of such projects. The first three discoveries or developments from which production may result were certified under this program during March. These are a manganese deposit near Batesville, Ark., a mica deposit near Franklin, N. C., and a tungsten deposit near Fresno, Calif.

To date, 246 exploration contracts have been executed covering 22 minerals and providing for exploration in 26 states and in Alaska. Most of the contracts cover lead, zinc, and copper for which the Federal share is 50 per cent of the costs of exploration, repayable out of any royalties realized. Seventy per cent of the contracts in force are with small operators.

Using counterpart funds made available under the Mutual Security Program, the United States acquired materials for the strategic stock pile from the free nations amounting to $82 million by the end of 1951.

In addition, $122 million were used for exploration and development of additional sources of critical materials and for enlarging the capacity of existing sources. As a result of the more important of these projects, the United States will obtain bauxite from Jamaica, lead and zinc from French Morocco, and industrial diamonds from French Equatorial Africa.

More than 80 projects involving some $200 million for the exploration, development, and procurement of strategic materials from foreign sources are under active consideration by the Defense Materials Procurement Agency. These projects are expected to yield important quantities of copper, manganese, nickel, cobalt, columbite, tantalite, chrome, and tungsten.

Stress Corrosion

STRESS-CORROSION cracking, caused by the combined action of stress and corrosion, can be responsible for the spontaneous service failure of objects ranging from brass cartridge cases to stainless-steel coffee urns. Although the problem is an important one, much remains to be learned about the mechanism of stress-corrosion cracking. A continuing investigation at the National Bureau of Standards, conducted by Hugh L. Logan of the NBS corrosion section, now provides new data on some of the mechanical and electrochemical phenomena involved.

Corrosion is generally considered to be an electrochemical phenomenon, involving the flow of minute electric currents between areas of different potential. When most metals are exposed to ordinary atmospheres, a thin oxide film is quickly formed that tends to protect the metal from further corrosion. According to the most generally accepted theory, which the NBS study tends to confirm, stress-corrosion cracking starts with a scratch or break in this protective film. When the protective film is broken through, the freshly exposed metal is more anodic (more negative) than the surrounding film-covered surface, and if moisture is present an electric current flows that causes the metal to be removed from the exposed area.

To get a better understanding of the forces at work in stress corrosion, the NBS investigators measured electrochemical potentials of five alloys in normal film-covered and film-free conditions, both stressed and unstressed. Specimens were immersed in a suitable electrolyte, and potentials were determined using a calomel reference electrode of the saturated KCl type.

Studied were an aluminum alloy, a magnesium alloy, two brasses, a low-carbon steel, and a stainless steel. Potentials were measured first for unstressed specimens having normal thin oxide films resulting from ordinary atmospheric exposure. Potentials were then measured for the same specimens after the filmed surfaces had been removed by abrasion with metallographic polishing paper. The abrading was done in an inert-gas (argon) atmosphere in a dry box, and the potentials were measured without removing the abraded specimen from this atmosphere. Each metal studied was more cathodic (more positive) in the normal film-coated form than in the abraded form, by amounts ranging from approximately 0.12 volt to 0.76 volt.

The electrochemical solution potentials of the same alloys, in the normal film-covered conditions, were then measured with stress applied. It was postulated that, when tension is initially applied to a metal, small breaks develop in the protective film, giving corrosion a chance to get started before a fresh film can form. If the electrochemical potential of the unprotected area

alone could be measured, it would presumably be roughly the same as that of a film-free surface. Measurement of change of potential with stress has been attempted before, but the attempts have generally been unsuccessful. The difficulty of measurement in the past has arisen because the total area of conducting through film-covered surface of the specimen has been very much larger than the area in which the film is broken under stress. When a calomel electrode is placed in an electrolyte in which the test specimen is immersed, the potential readings obtained represent essentially the potential of the relatively very large film-covered surface; the film-free surface is so small by comparison that it may not even be possible to detect any change of potential when the specimen is stressed.

At NBS this measurement problem was solved by coating an entire notched specimen with a nonconducting waterproof lacquer, then using a razor blade to remove a narrow band of lacquer at the root of the notch. With specimens thus prepared, the only potential being measured was that of the narrow band of metal at the root of the notch where the stress was concentrated. With fairly rapid application of stress, the film-free area then became a substantial fraction of the total nonlacquer-covered area and the potential became more negative as the stress was increased. If the stress was held constant for some time, the solution potential generally reverted quickly to that of the unstressed metal. If the stress was increased rapidly, however, the measured potential tended to approximate that of a film-free surface as the point of fracture was reached.

Ductile Cast Iron

A RECENT study by Alexander I. Krynitsky and Harry Stern of the National Bureau of Standards, substantially increases available information on the effects of different additives on the formation of nodular graphite. Because of its ductility and superior strength, nodular cast iron (having a nodular graphite structure) has excited considerable interest since its production was first described in 1948. Both cerium and magnesium, added in small amounts to the molten iron, have been used successfully to produce ductile cast iron.

Additives investigated at NBS were magnesium, magnesite, iron sulphide, calcium, nickel-chromium-molybdenum, and boron. Cerium was not included, because published information on its application as a nodulizing agent was relatively complete when the study was begun. Besides the different additives, the investigation included such variables as composition, melting and pouring temperatures, and cooling rate.

In the NBS study, completely nodular graphite was obtained only in iron containing magnesium in excess of 0.03 per cent. Two types of nodules were observed, radial and structureless, the structureless types frequently having a crystalline core. Results with magnesite, magnesia, and the other additives were essentially negative. However, oval or irregular patches of graphite—not true nodules—were observed in iron treated with magnesia, iron sulphide, and boron. Only a few nodules were observed in calcium-treated specimens, but this was probably because of the rather small amount of calcium retained; other investigators have reported 100 per cent nodular-graphite structures in irons having calcium contents higher than were obtained in this investigation.

The experimental method involved melting cast irons of various compositions in a high-frequency induction furnace. After the melt reached the desired temperature, the nodulizing agent under study was added. In general, the melt was next inoculated with 0.4 per cent silicon and then cast in round bars. These were examined chemically, spectrochemically, photomicrographically, and for hardness.

Initial experiments with magnesium as the nodulizing agent used commercially pure magnesium. However, the violence of the reaction between pure magnesium and molten iron made close control of these early melts difficult. This method of addition was therefore abandoned, and the magnesium was supplied in the form of 80 Cu-20 Mg alloy.

The effect of cooling rate on microstructure was determined by casting wedge-shaped bars. The cooling rate, greatest near the apex of the wedge, was observed at intervals along the bar by means of thermocouples.

Rapid cooling favored nodule formation, but the effect of the cooling rate decreased with increase in magnesium content. No relation between nodule formation and pouring temperature or maximum heating temperature was observed. Results of the investigation support the belief that nodular graphite is formed in the melt during solidification, and that patches of graphite are produced after solidification by decomposition of carbides.

Seamless Tubing

A DETAILED survey of the best United States practices in producing steel for the manufacture of seamless tubing is now available to the public, the Office of Technical Services, U. S. Department of Commerce, announced recently.

According to the survey, the steels used for seamless tubes must be sound both externally and internally because of the severe forging operations involving in piercing. The report treats mainly the methods employed in melting basic electric steel and casting by bottom-pouring to obtain steel of best quality for this purpose.

The report shows that amount and time of additions of iron ore to the electric-furnace melt are important in production of highest-quality rimmed or killed types of steel. A strong boil of the molten bath must be maintained by correct ore additions in order to avoid hydrogen absorption with attendant lowering of ductility and soundness of the cast ingot product. The optimum time of manganese addition to the melt is also discussed with respect to its effect on steel-ingot quality and efficiency of manganese recovery.

Bottom-pouring is used instead of the more common top-pouring methods in order to get improved ingot surface and yield. Technical details of ladle and runner refractories and design in American and German practice are compared. Controlled pouring temperatures and speeds, mold preparation and coatings, new heat-generating or insulating methods for hot tops, and metallurgical inspection controls are other practices employed to obtain high yields and an improved steel-ingot product.

PB 106 027, "Electrical Steel Ingot Practice for Seamless Tube Manufacture," 15 pages including bibliography, is available at 50 cents per copy in mimeograph form. Orders should be addressed to the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the Treasurer of the United States.

Tube-Mill Machines

TWO modern steel-tube processing operations which are producing 180 fpm of tubing have been completed by Ford Motor Company.

Designed for quick conversion to defense production of welded tubing up to 5 in. in diameter, the mills are located at the company's Mound Road plant, near Detroit, Mich.

One is nearly 400 ft long and turns out tubing for axle hous-

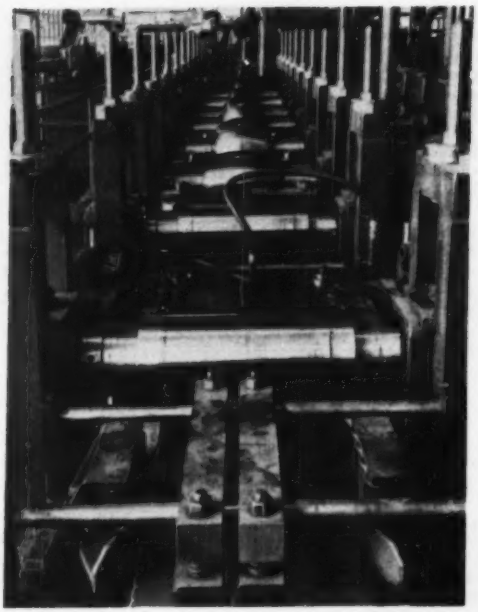

FIG. 3 ROLLS OF THIS GIANT TUBE-MILL MACHINE PULL AND FORM COILED STEEL INTO HOUSINGS FOR REAR AXLES AT FORD MOTOR COMPANY'S MOUND ROAD PLANT

ings at a rate of 75 fpm. The other, 175 ft long, is producing 105 fpm of tubing for drive-shaft assemblies, a speed said to be unequaled in industry on like-quality steel.

The manufacturing procedure of both mills is approximately the same and begins with the automatic unwinding of coiled steel from huge drums. Steel stock enters the loading end of the mill and is gradually formed into tubular shape by a series of parallel rollers. The tube is then welded automatically and the flash removed.

Following this, the tube stock is cut to desired length by a process that virtually eliminates waste. Tube stock then is moved automatically to annealing furnaces and transported to other manufacturing buildings to be processed into rear-axle and drive-shaft assemblies.

Materials-Testing Reactor

THE materials-testing reactor, designed to produce a flow of intense neutron radiation, is now in operation at the National Reactor Testing Station, Idaho Falls, Idaho.

The new reactor became "critical "on March 31, and is gradually being brought up to full power by the operating contractor, Phillips Petroleum Company, of Bartlesville, Okla.

Research and development work for the MTR was done by the Argonne and Oak Ridge National Laboratories and engineering design by the Blaw-Knox Construction Company of Pittsburgh. The Fluor Corporation, Los Angeles, was the major construction contractor.

A mockup, or pilot model, was constructed at the Oak Ridge Laboratory and used to aid the design and then to train operators. The reactor core was fabricated at Oak Ridge and shipped to the testing station for reassembly.

The materials-testing reactor provides much-needed facilities for determining the effect of intense radiation on materials considered for use in the structures, heat-transfer systems, and shields of new reactors. A schedule for its initial use was established months ago.

The MTR contains more than 100 ports in which specimens can be exposed to neutron bombardment. While the reactor operates primarily on thermal, or slow, neutrons, it also can subject specimens to neutrons with intermediate and fast energies.

In addition to its testing function, the MTR contains features which may prove of value to reactors still on the drawing board. For example, its fuel is enriched uranium in units designed for rapid heat transfer. The coolant is water, circulating at high velocity.

The reactor, including engineering design and inspection but excluding research and development, was constructed within the original cost estimate of $18 million.

600,000-Lb Testing Machine

CENTRAL feature in the new Structures Laboratory at Purdue University is a new 600,000-lb Baldwin-Tate-Emery Universal testing machine towering 30 ft in height. The floor of the building, 30-in-thick reinforced concrete with

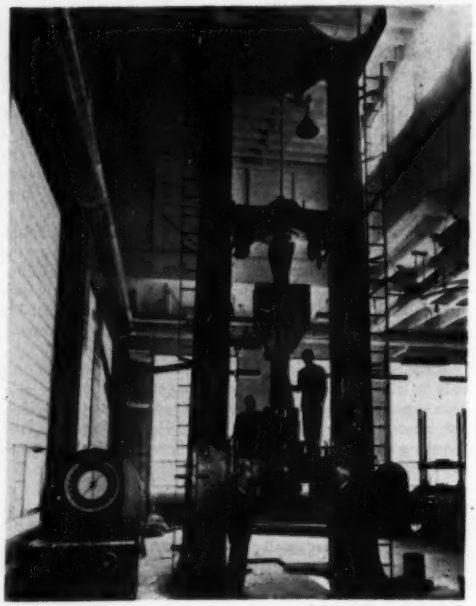

FIG. 4 DOMINATING THE NEW STRUCTURES LABORATORY AT PURDUE UNIVERSITY IS A NEW BALDWIN-TATE-EMERY UNIVERSAL TESTING MACHINE OF 600,000 LB CAPACITY IN TENSION OR COMPRESSION

(Tensional specimen in the machine is a gusset for a joint in a railroad bridge structure. The comparative strength of bolted and riveted joints is being determined.)

two embedded 5 × 7-ft girders, makes a foundation that can be used for transverse tests of structural specimens up to 58 ft long (from wall to wall of the building). Anchors in the floor on 6-ft centers can hold a load of 100,000 lb either vertically or horizontally. Machine clearance for specimens is 22 ft vertically and 6 ft between columns.

The laboratory will be used mainly for research on structures of concrete, steel, and other materials. Most of the work will be done by graduate students under the direction of faculty members. The testing machine has a number of special features that were provided for testing in these fields. The detailed specifications were the result of co-operative effort between Purdue's engineering department and Baldwin-Lima-Hamilton Corporation. This is also the first machine of this capacity to have columns and base made as weldments instead of steel castings.

The Association of American Railroads is sponsor of two projects now in progress at Purdue in which the new machine will be used. They are (1) a study of static and fatigue strength in bridge hangers and joints, both full-scale and models, and (2) fatigue in 8 × 16-in. timbers on a 13-ft span.

The joints have gussets such as that illustrated in Fig. 4, which is 5 ft long and 3 ft wide. They are expected to fail at slightly under 600,000 lb. Small-scale tests indicated that joints made up with high-tensile-strength bolts stressed up to their elastic limit through their clamping actions are more effective than riveted joints in resisting fatigue. Tests of full-scale joints may verify this and throw light on the question.

Bonded on these joints and bolts are many Baldwin SR-4 resistance-wire strain gages which will permit determining the distribution of stress and magnitude of strains, and perhaps may indicate the possibility of improvement in design.

Column Research Council of The Engineering Foundation is sponsoring another project which includes a study now in progress on the effect of initial eccentricities upon column capacity and a new study of the effect of residual stresses in columns.

The Research Council for Riveted and Bolted Structural Joints is also sponsoring a project on fundamental relations of fatigue strength on riveted and bolted joints.

Navy Boiler Test Facilities

FULL-SCALE testing of the largest marine boilers will be made possible by a $3,500,000 expansion to the Naval Boiler and Turbine Laboratory at the Philadelphia Naval Shipyard.

This unique laboratory, plans for which are being developed by the Naval Civil Engineers, is the only facility in the United States, and probably in the world, capable of testing full-sized boilers for large naval and other maritime vessels. Such full-scale testing of one boiler of each new type used, eliminates practically all major defects before boilers are installed in ships. This is one of the principal reasons for the steaming superiority of the U. S. Navy, it was pointed out.

Plans and specifications for an addition to the present laboratory include a 120 × 250-ft one-story section with heavy cranes where three or more boilers, including those for large carriers, may be tested simultaneously. An attached three-story building will house machine and electrical shops, a laboratory, and engineering and administrative offices.

Since the boiler laboratory was established, working pressures, temperatures, sizes, and capacities in Navy boilers have increased, making existing facilities inadequate for testing boilers of the present and future.

The new facility, will use less manpower, testing time, and funds, and will provide for safer tests.

Airship Model Testing

TESTING the model of an airship under water to see how it will behave in the air is a new departure at the Experimental Towing Tank of Stevens Institute of Technology, Hoboken, N. J. Such tests are being carried out on the model of a ZP4K blimp for the Bureau of Aeronautics, Navy Department. The purpose of the tests is to determine the airship's control characteristics in the air.

The results of these tests will come out as numbers giving hydrodynamic characteristics useful for studying control problems. The numbers will also provide data which a "mechanical brain" can use to compute various maneuvers.

A plastic model of the airship, approximately three feet long, will be built. Alternative tails containing various arrangements of control surfaces will be attached. Two arrangements of gondolas will be tested.

The model will be towed under water on a rotating-arm apparatus. It will be moved in a circular path for various radiuses of curvature and with various settings of the control surfaces. By means of formulas developed in model-testing practice, characteristics determined in this way can be used to predict the performance of a full-sized blimp in air, its natural element.

If these exploratory tests prove useful for this kind of work, investigations will be made with other models of airships.

Future Flying Boats

ACCORDING to The Society of British Aircraft Constructors, British designers are well ahead with projects for even larger flying boats than the Saunders-Roe Princess (see "The Flying Boat," by Henry Knowler, MECHANICAL ENGINEERING, October, 1951, pp. 799–802). In fact, it is reported that new types of flying-boats are being designed for work hitherto done by landplanes, and for operations even beyond the foreseeable capabilities of landplanes. Among these designs are water-based jet bombers capable of flying as fast as sound, Diesel-driven flying boats with a duration of 35 hours, and transports weighing over 250 tons.

Details of some of these design studies have been given by Henry Knowler, chief designer of the Saunders-Roe Company. His design studies for the future are based on tests with revolutionary types of hull form. The tests were made with very small-scale dynamic models, which were catapulted into a large water tank.

Conventional hulls have a step-up below the fuselage so that the boat can lift free of the water on take-off. Mr. Knowler says this step-up, which spoils streamlining, will have to go. On his models, he has been testing special surfaces which give the same effect as a stepped-up hull while the boat is taking off along the water, but which slide up into the streamlined fuselage as soon as the boat is air-borne. These retractable surfaces mean that the boat is a flying boat on the water but, when in flight, has the streamlined fuselage of the fighter.

Mr. Knowler plans retractable hydrofoils—airfoils which operate under the water and lift the hull off it, and hydroskis—ski-type floats for high-speed fighters, which will completely retract in flight. The following design studies were mentioned by Mr. Knowler:

1 Ocean patrol flying boat. A 150,000-lb boat capable of cruising at 400 mph for a gross range of 8000 miles or, at 200 mph for 35 hours. A possible power plant would be the Napier "Nomad," the new compression-ignition Diesel turboprop. These patrol boats, on antisubmarine patrol, might alight at sea, and lower special detectors beneath the surface. It is now pos-

sible to design boats capable of landing safely in waves up to 9 ft high from trough to crest.

2 Intruder bomber. Methods have been found of carrying bombs in the hull of a bomber boat, and though operating from water, it could fly in the transonic region. The project is for a pressurized sweptwing craft with two jet engines.

3 Military transport. The size of the future flying boat is virtually unlimited, states Mr. Knowler, but a limiting factor in the immediate future will probably be engine power. For this reason, the upper limit "for some time" will be about 270 tons.

4 Commercial flying boat. The Duchess type, with six straight jet engines, is designed to fly 1500 miles at 450 mph.

5 Fighter flying boat. Fitted with hydroskis, the jet engine would be set above the fuselage with a Pitot entry. The design has sharply sweptwings and tailplanes set high on the fin.

Mr. Knowler concludes by saying that the first atomic-powered aircraft may well be a flying boat. The reason is that for a reactor of 100 tons, an aircraft of 200 to 300 tons would be necessary. This is a big aircraft to contemplate as a landplane but as a flying boat such a size would be acceptable without query, Mr. Knowler states. The cruising speed of this first atomic aircraft will probably be below the speed of sound.

Convertible Jet Aircraft

HIGHER forward speeds while retaining all the advantages of vertical ascent and descent are proposed in a design of a jet-powered convertible aircraft, described in an article appearing in the January, 1952, issue of the *New York Professional Engineer*, by I. B. Laskowitz, Mem. ASME, a consulting engineer in Brooklyn, N.Y.

The design embodies the elements of the autogiro, the helicopter, and the fixed-wing plane in a simple manner by applying the exhaust from a turbojet engine to a hollow-bladed rotor or diverting the exhaust gases partly or wholly when desired rearward to produce a direct forward thrust. In flight the rotor is constantly in motion acting as a helicopter rotor when power is applied to it or as an autogiro rotor when no power is applied to it and the craft is propelled forward by the direct forward thrust of the jet. The fixed wing comes into play in conjunction with the direct thrust to relieve the load on the rotor, taking as much as 85 per cent of the total load at higher speeds. The rotor blades may be hinged back and the fixed wings hinged up to reduce the storage space required on the ground.

Fig. 5 shows a large transport type of aircraft incorporating the foregoing principles. Control valves *F* and *G* are interconnected and operated by a lever near the pilot. As a helicopter, valve *F* is fully opened and valve *G* fully closed. A cyclic pitch (azimuth) stick and collective pitch stick connected to the swash plate give all the normal control as in a helicopter. Optional automatic control of collective pitch is provided. Conversion to operation as an airplane is done by shifting the lever connected to valves *F* and *G* forward which gradually closes valve *F* and opens valve *G* for providing the direct forward thrust.

The machine shown has a gross weight of 18,000 lb and is powered by two turbojet engines capable of burning either kerosene, gasoline, or light Diesel oil. According to Mr. Laskowitz, performance calculations indicate that the machine could carry 21 to 28 passengers, a pilot and copilot, and attain speeds of 250 to 300 mph with a range of more than 300 miles for the 21-passenger and more than 140 miles for the 28-passenger machines. With one engine not operating the aircraft is said to be capable of carrying its full load and attain speeds up to 200 mph and a maximum range equal to that when operating both engines.

Collapsible Helicopter

A HELICOPTER powered by small jet engines, designed so that it can be dropped from larger planes, unpacked by two men, and put in the air in approximately 20 min, is being developed under sponsorship of the Army Ordnance Corps, the Department of the Army announced recently.

The new aircraft is designed for air evacuation, transport, and supply, as well as for observation. The lightest and smallest aircraft being developed for the Army, it weighs less than 300 lb, is six feet high, and can be collapsed into a 5 × 5 × 14-ft container. See frontispiece, page 444, in this issue.

Versatility of the helicopter is demonstrated by its adaptability to carry two men side by side, or tandem, in twin external litter carriers. No modification in the basic frame or in the power plant is necessary.

Designated the XH-26, the aircraft is basically a one-man

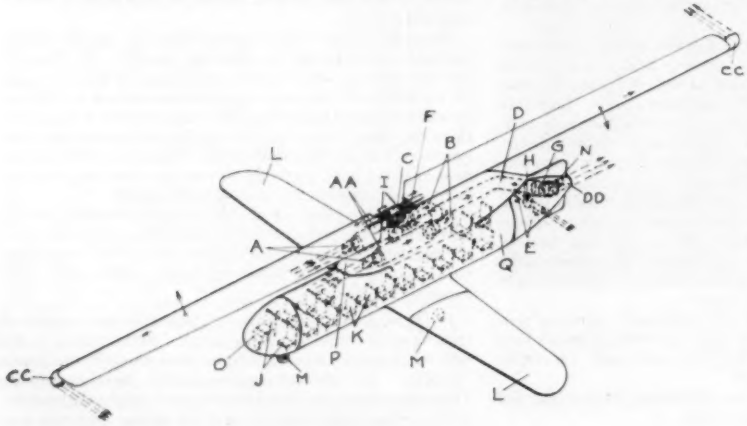

FIG. 5 SKETCH OF JET-POWERED CONVERTIBLE AIRCRAFT

[*A*, Engine intakes; *AA*, turbojet engines; *B*, engine exhausts with check valves; *C*, rotor exhaust tube; *CC*, rotor-blade exhaust nozzles; *D*, forward-thrust exhaust tube; *DD*, forward-thrust exhaust nozzle; *E*, directional-control exhaust tubes; *F*, rotor exhaust control valve; *G*, forward-thrust exhaust control valve—control valves *F* and *G* interconnected; *H*, directional control-exhaust control valve operated by footpedals; *I*, blade-pitch changing arms connected to swashplate for collective and cyclic pitch control; *J*, pilot and copilot seats; *K*, passenger seats or cargo; *L*, fixed wings hinge up; *M*, landing gear, retractable; *N*, afterburner (optional); *O*, instrument panel; *P*, engine compartment; *Q*, cabin.]

FIG. 6 NEW ARMY COLLAPSIBLE HELICOPTER, THE XH-26, DESIGNED SO THAT IT CAN BE DROPPED FROM LARGER PLANES, UNPACKED BY TWO MEN, AND PUT IN THE AIR IN ABOUT 20 MIN

ship powered by two 16-lb pulsejet engines, one on each end of the rotor blade. Loaded for flight, the plane will weigh about 700 lb. This weight includes the pilot, radio equipment, and fuel. Top speed of the XH-26, being developed by the American Helicopter Company of Los Angeles, Calif., is 80 mph. Flight time is an hour and a half without refueling.

The ship is powered by the two AJ6.75-in. pulsejet engines which are easily started. Each engine has only one moving part. When worn, the part can be replaced in a matter of a few minutes at low cost. The plant can burn gasoline, kerosene, or Diesel fuel oil.

The XH-26 is still in the development stages and no orders have been placed by the Army for its procurement to date.

British Gas-Turbine Locomotive

THE first British gas-turbine locomotive—designed and built for British Railways by Metropolitan-Vickers Electrical Company, Ltd.—is now undergoing final tests before going into service with the Western Region, according to the April, 1952, issue of *The Overseas Engineer*.

It is a double-bogie, gas-turbine electric locomotive with six driving axles. The turbine is rated at 3000 hp and, with electric transmission, provides for a maximum tractive effort of 60,000 lb. The continuous rating is 30,000 lb.

The principal features of the locomotive were determined by Great Western Railway service requirements; i.e., that it should be capable of hauling the heaviest passenger trains on the Western main routes over gradients of up to 1 in 36 and at speeds approaching 90 mph. The locomotive builders were particularly anxious that this new power unit should be readily applicable to overseas railways where heavier duties might be encountered and where derating might be imposed by unfavorable ambient temperature and altitude.

A nominal output of 3500 hp at the turbine coupling was therefore selected, and the design of the turbine, reduction gear, and electric-transmission equipment was based on that figure, although the blade profiles in this particular machine limit the continuous output to between 3100 and 3200 hp. A greater output can be obtained by changing certain blades should the need arise.

The more important design features dictated by service requirements are (1) the double-bogie arrangement of running gear with the equivalent of swing-bolster action for good riding up to 90 mph, (2) an oil-fired train-heating boiler to feed the steam heaters on the train, and (3) an automatic control scheme to bring the driving technique within the capacity of the regular staff without highly specialized training. The control equipment installed is of Western Region design.

The body structure contains the power plant and a driving cab at each end; it is carried on the two bogies by swing links attached by rubber resilient universal joints to permit controlled swing-bolster action and bogie pivoting, without the use of actual bolsters which would have required more space than was available between the bogie frames and within the fixed wheel base. Each bogie has three driving axles, each driven through a single reduction gear by a traction motor suspended on the axle and from a support on the bogie frame.

The turbine rotates at 7000 rpm when delivering full load, and drives three main traction generators at 1600 rpm through single-reduction gearing. The reduction-gear unit has two output shafts; one drives two of the main generators in tandem and the other drives the third main generator, the auxiliary generator, and the exciter.

The turbine, reduction gear, and group of generators are mounted on a common bedplate together with the main fuel and lubricant pumps, forming a self-contained power unit which is installed in the locomotive body on three support points on its main underframes. Each of the three main generators supplies two of the six traction motors. The motors of each pair are connected permanently in parallel.

The prime mover is a single open-cycle gas turbine without heat exchanger; the cycle of compression, heating, and expansion of air is carried out in a compressor, combustion chamber, and turbine arranged in line and built into a single straight-through unit. A 15-stage axial flow machine, the compressor has a pressure ratio of 5.25 at 7000 rpm and a mass flow of 50 lb per sec; it runs in two sleeve-type bearings.

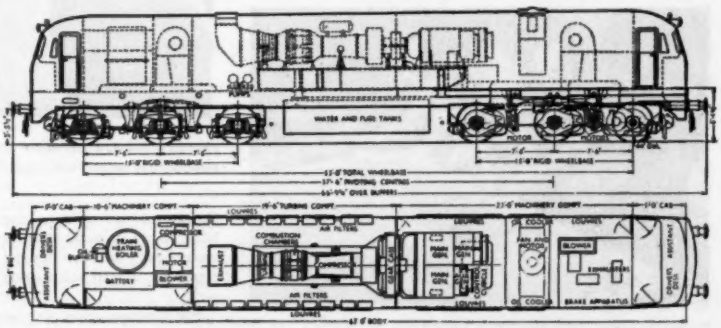

FIG. 7 LAYOUT OF LATEST BRITISH GAS-TURBINE LOCOMOTIVE

The turbine is a 5-stage unit also running in two sleeve-type bearings and its rotor is direct-coupled to that of the compressor. Composed entirely of heat-resisting steel, the combustion chamber consists of six flame tubes with axes parallel to the machine axis and connected by flexible connection pieces at one end to the compressor outlet and at the other end to the turbine outlet.

The three shafts of the reduction gear lie in a horizontal plane, the middle one carrying the pinion and each of the others a gear wheel. The pinion is made from case-hardened steel, the teeth profiles being ground after hardening. The gear-wheel rims are of 65/72-ton chromium-molybdenum steel, with the teeth finished by the shaving process.

Plastic Sports-Car Body

FIRST commercial production of a low-cost plastic automobile body was announced jointly by the Glasspar Company of Costa Mesa, Calif., and Naugatuck Chemical Division, United States Rubber Company.

The body, which is claimed to be dentproof and rustproof, is constructed of Vibrin polyester plastic and layers of glass fiber, a combination which, for its weight, is said to be stronger than steel. Of custom sports-car design, the body sells at a price of $650. It is being produced by the Glasspar Company and is available to persons who want to mount it on a chassis purchased separately.

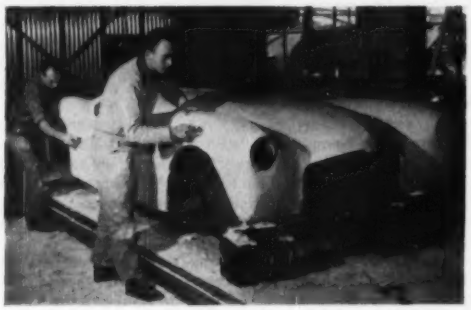

FIG. 8 INITIAL STEP IN MAKING PLASTIC-GLASS FIBER AUTO BODY IS TO MAKE A WOOD AND PLASTER MALE MOCK-UP, WHICH GIVES SHAPE AND DESIGN OF BODY

FIG. 9 VIBRIN RESIN AND FIVE LAYERS OF GLASS MAT AND GLASS CLOTH ARE USED TO BUILD FEMALE PRODUCTION MOLD

Currently the body is available in one design which fits a frame with a 100-in. wheel base. As production increases, Glasspar expects to make available a variety of body styles to fit frames of various sizes.

The body, molded in one piece, is approximately 0.2 in. thick and weighs only 185 lb. According to the makers, it is strong and resilient and will not dent under the punishment of accidents which now result in crumpled fenders and doors.

FIG. 10 FEMALE PRODUCTION MOLD IS JOINED TOGETHER WITH PARTING AGENT AND INITIAL COAT OF VIBRIN RESIN APPLIED; WORKMEN ARE STARTING LAY-UP OF GLASS MAT FOR ACTUAL BODY

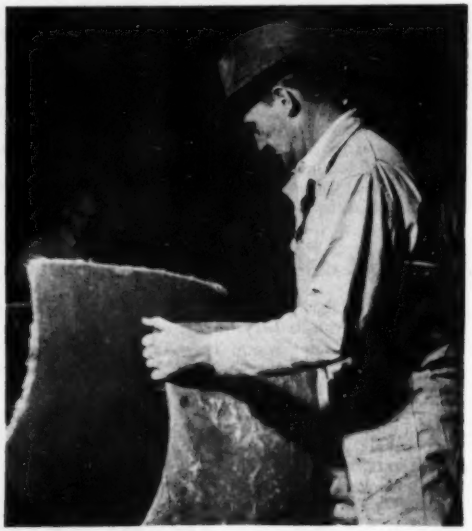

FIG. 11 FINAL AUTO BODY COMES AWAY SMOOTHLY FROM FEMALE PRODUCTION MOLD; NOTE SMOOTHNESS OF FINISH ON FINAL BODY AT TOP

Because of its resiliency, the Vibrin-glass combination springs back to its original shape after impact. Breaks are possible under heavy impacts, but the material can be easily and cheaply repaired. It will neither rust nor oxidize and it will hold paint well.

For demonstration purposes, the first body produced has been mounted on a custom-built sports car consisting of a special frame and supercharged engine.

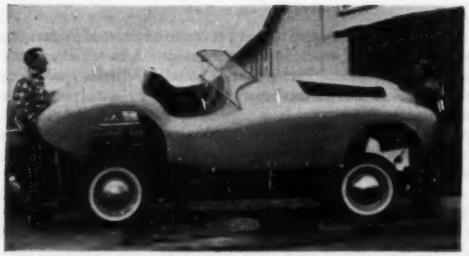

FIG. 12 VIBRIN PLASTIC-GLASS FIBER AUTO BODY WEIGHS APPROXIMATELY 185 LB; ITS AVERAGE THICKNESS IS 0.2 IN.

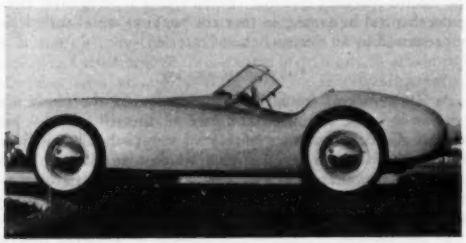

FIG. 13 COMPLETED SPORTS CAR WITH FIRST PLASTIC BODY TO BE PLACED INTO PRODUCTION ON A COMMERCIAL SCALE

To test its strength, it was driven deliberately into a tree at a speed of 25 mph. The test resulted in a crack approximately 14 in. in length at the point of impact on the right side of the car near the windshield. The crack was repaired with a patch of glass fiber and plastic within one hour.

Initial step in the manufacture of the body is to produce a wood and plaster mock-up which gives the car body its design and acts as a master mold. The wood and plaster mold is given an extremely smooth finish since it will impart this finish to the female production mold and ultimately to the final body. This is done by the use of a sealer and sanding.

The wood and plaster mold is then waxed and given a coat of polyvinyl acetate which combination acts as a parting agent and assures that the female production mold will break away cleanly and easily. A "hot coat" (fast-curing coat) of Vibrin plastic is applied to the plaster mock-up as an overlay. This assures a smooth finish on the female production mold which is free of pinholes and rough spots. The rest of the female mold consists of five layers of glass-fiber mat and glass cloth bonded with Vibrin plastic.

Layers of glass mat and cloth are laid up dry. Plastic is then applied and squeegeed to remove air bubbles and assure even dispersion. After cure, steel brackets are attached to female mold for rigidity and to permit easy handling. The female mold is cut in half at the driver's seat while still on plaster mock-up.

Flanges of glass cloth and plastic are attached at the point where mold was cut. These flanges assure that the female mold can be joined together smoothly after it is broken away from the plaster mock-up. The female production mold is removed from the plaster mock-up in two halves. The inside of each half is spot-finished. Careful finishing is needed to assure smooth surface on the final body. The two halves of the female production mold are then joined together by bolts through flanges at the point where the mold was cut for release. The female production mold is given a coat of wax and polyvinyl acetate parting agent to assure easy release of final body.

The surface of the female production mold is given a fast-curing coat of Vibrin plastic as an overlay. This essential step assures smooth surface on final body which is free of pinholes. A glass mat and glass cloth are laid up over the coat of Vibrin plastic, and a coat of plastic is applied over glass cloth. The plastic is squeegeed to assure uniform dispersion and to eliminate air bubbles. This combination is allowed to harden. The process is then repeated until desired thickness is obtained. Final thickness of body is about 0.2 in.

The body is allowed to cure in the female mold. Portable infrared lamps may be used to speed curing process. The body is then removed from the female production mold, buffed, corners smoothed, and paint applied.

Cold-Rubber Production

A 30 PER CENT increase in output of "cold" GR-S American rubber is made possible by a major improvement in manufacturing process employed at the government-owned Port Neches, Texas, rubber plant, according to the B. F. Goodrich Chemical Company, Cleveland, Ohio.

It was explained that the new process, using existing plant facilities, increases reaction rates 30 per cent or more. Over-all cost of the rubber is lowered by a reduction in the amount of auxiliary chemicals used to promote the rubber-forming chemical reaction. The cold GR-S so produced is appreciably more uniform in quality, and the process requires less exacting technical control.

Now in full-scale production at the Texas plant, the process uses a tetra-sodium salt of ethylene diamine tetra-acetate, which forms complex compounds with the iron, calcium, and magnesium ordinarily found in water. This chemical is added to the water used in making cold GR-S latex.

Time required for the rubber-making reaction is decreased by 3 to 4 hours, which results in more cold rubber produced in each polymerizer during a given period. By using the water-treating chemical, smaller amounts of catalysts are necessary.

B. F. Goodrich Chemical Company, which operates the Port Neches, Texas, plant for the Reconstruction Finance Corporation, began experimentation on the new process in 1949. The company also explored other methods of increasing reaction rates and improving uniformity. Subsequently, better catalysts were introduced commercially in 1950 and 1951, cutting the reaction time from about 18 to 13 hours. This latest improvement brings the reaction time to approximately 9 hours. The two-year commercial development program has effectively contributed toward doubling the reactor capacity for cold rubber without the addition of any new equipment.

Information on the new process has been made available to other companies operating GR-S plants for RFC.

Machining and Grinding

THE potential values of new processes for machining and grinding have been evaluated, with the conservation of diamond bort being of special interest, in a report on "New Processes for Machining and Grinding." The report has been submitted through the National Research Council to the Research and Development Board by the Minerals and Metals Advisory Board.

Some of these new processes, the report states, appear promising as methods for conserving diamond bort when grinding sintered carbides; and they appear to offer promise for forming

and finishing other hard-to-machine materials besides carbides.

The electromechanical and electrochemical types of processes are limited to shaping and finishing electrically conducting bodies such as metals and carbides. Abrasive types of methods, including diamond-wheel grinding and ultrasonics, are capable of cutting all hard materials.

According to the report, diamond-wheel grinding has for some time been the only practical method for shaping and finishing cemented-carbide tools and tungsten-carbide projectile cores. These job items account for approximately 70 per cent of the diamond-bort consumption in this country. At the present time, imports and reclamation of diamond bort are limited and although there may be some increase, these might not be sufficient to produce the tools and military end items in the event of a substantially increased preparedness or mobilization program. In addition, many new military items, which involve hard-to-machine materials, are being developed, and the anticipated rate of production of these is very large. This will make the diamond-bort procurement situation even more serious.

Therefore there is a need for the development of new processes that do not require diamond bort.

The following summarizes the essential descriptions and features of each of the processes, as currently practiced or being developed in the United States.

ELECTROLYTIC PROCESS

Electrolytic grinding is usually performed by a revolving metal-disk cathode in close proximity to an anodic workpiece while an electrolyte is applied to the disk and workpiece in the same manner as a coolant is applied to a grinding wheel and work. The method is usable for removing stock from electrically conducting bodies such as metals or metal carbides. It appears especially suited for removing stock from large surfaces, but its applications are limited where very small surfaces need be ground or for drilling of small-diameter deep holes.

The electrolytic process utilizes steady direct current and a highly conducting electrolyte. Relatively low voltages of less than 25 volts and usually between 16 and 18 volts are used. It is characterized by low local heating and essentially no consumption of the cathode. In this process a true electrochemical action takes place in accordance with Faraday's law. With fixed current density the rate of stock removal, in terms of volume per unit of time, is proportional to the effective area of the work exposed to the electrolytic action. Cathode-anode spacing and polarization effects appear to be critical factors in the electrolytic process, particularly for shaping or finishing cemented carbides.

ELECTRO-SPARKING PROCESS

In the electro-sparking method, stock is usually removed by making the work one of the electrodes in a properly designed circuit. Rapidly pulsed current (usually oscillatory) of the spark-discharge type is passed between the work and the other electrode in a dielectric fluid. The method is used for removing stock from electrically conducting bodies such as metals or metal carbides and is especially suited for forming small-diameter deep holes of any shape.

The electro-sparking process is characterized by relatively high electrode consumption. Local heating is not experienced under ideal operating conditions. The range of voltage usually employed is between 40 and 300 volts. In a pure electro-sparking process the electro-discharge is initiated by the voltage across the dielectric. The process is electromechanical and not electrochemical (as the electrolytic process). The stock is removed by a sparking action and the metal or metal-carbide particles are carried away suspended in the dielectric fluid.

ELECTRO-ARCING PROCESS

Cutting by the electro-arcing process is performed by making the work anode with an arc maintained between the work and the cathode. The method usually utilizes pulsating direct current using a moderately conducting electrolyte such as water-glass solution. It is especially suitable for rapid cut-offs of hard metals and carbides and may be faster than existing cut-off procedures. However, in a pure electro-arcing process, somewhat rough finishes are obtained.

In the electro-arcing process, low voltages of less than 25 volts are usually used. For a pure electro-arcing process the electro-discharge is initiated by contacting the electrodes and current is carried by vaporized metal ions. The process is commonly characterized by the deposition of some nonconducting film (such as silica) on the work and high local heating is evidenced with moderate consumption of the cathode. As in the electro-sparking method, electro-arcing is essentially electromechanical in nature, in that the metal or metal carbide is not removed by an electrochemical reaction.

ULTRASONIC PROCESS

As differentiated from the electro processes the ultrasonic process does not utilize electric current directly for stock removal. Cutting or stock removal is accomplished by abrasive action at high frequency and low amplitude. Unlike the electro processes, the ultrasonic technique grinds nonmetals or nonelectrically conducting bodies as well as electrically conducting materials.

In the ultrasonic process, the cutting or grinding tool is usually vibrated in the frequency range from 16,000 to 29,000 cps through an amplitude of not more than a few thousandths of an inch. The abrasive, which is usually 280-grit boron carbide, is carried in water to the tool and work. Other grit sizes and abrasive compounds, such as aluminum oxide and silicon carbide, may be used but these do not last so long as boron carbide. Consumption of the tool occurs during grinding and machining.

COMBINATION PROCESSES

In addition to the foregoing four processes, machines may be devised for effecting combinations of some of these four processes. For example, the combination of the electrolytic and diamond-wheel grinding has been tested and is being developed. For this combination process, a metal-bonded diamond wheel must be used for the cathode. The diamond particles act as insulating spacers, separating the work from the wheel, and as scrapers.

Machines have been tested and are being designed for effecting machining and grinding by electrolytic and/or electro-arcing actions. The same electrolyte or more than one electrolyte might be used by the same equipment which will serve for either the electro-arcing or the electrolytic process.

Electro-arcing, electro-sparking, and electrolytic actions might occur simultaneously during a grinding or cutting operation. Machines predominantly operate on the basis of one of the processes but there may be other process mechanisms superimposed. The superimposition of more than one mechanism or process in a cutting or grinding operation could markedly alter the results obtained.

The ultrasonic technique might be used in combination with one of the electro processes such as the electrolytic one. However, this has not as yet been tested.

None of the new processes is in actual commercial use except for shaping and finishing dies, the report concludes. However, a limited number of machines, based on these new processes, are becoming available for practical test work. For producing tools such as single-point tools, chip breakers, milling cutters, and

broaches, it will be necessary to carry the development work on these new processes through fairly extensive performance tests. These tests should be made not only on the machines but also on the tools themselves in order to adequately establish them as production units. At the same time, research and development on machine improvements and on learning more fundamentals should proceed in a more intensified manner. The performance tests might best be done in production shops and eventually they must be done there. However, it may be worth while to design special programs for accelerated performance tests to exploit the methods as rapidly as possible. Performance tests and other research and development should be carried out mainly by industry who have the real need for these new processes.

Diamond-Drill Performance

ANYONE equipped with a magnifying lens can recognize the directions of maximum hardness of industrial diamonds and learn how to install them in drill bits to obtain top efficiency without any previous training in crystallography, according to a Bureau of Mines Report released by the United States Department of the Interior.

Revolutionary in that it contains cutout model patterns for visual aid, the report avoids the scientific terms used by trained crystallographers and describes in simple language the rudimentary characteristics of diamonds. In addition, with the aid of cardboard models of the basic crystal forms, it enables a layman to recognize the special features of the diamond crystal's surface that are the definite guides to the location of the hard section of the stone.

Through x-ray diffraction, scientists learned that in each diamond there are directions—or planes—of unequal strength and resistance to abrasion. By plotting these directions on stereographic projections they delineated the hard regions on the surface of the diamond, but only crystallographers could readily interpret their diagrams. By first cutting out the models contained in the report, and then following the readily understood directions, it is relatively simple to acquire the know-how of the use of special faces, points, edges, and growth lines as a guide in orienting a diamond in such a way as to reduce wear and increase efficiency of the bit. Preliminary drilling tests indicate that bits in which the stones are oriented properly outperform those in which the setting is random.

The reader of the report is given specific instructions how to cut out the paper models and fashion the three orientation disks, one each of a cube, an octahedron, and a dodecahedron. Once the models have been assembled, a layman simply has to read the instructions contained in the report in order to learn how to get the most efficient service out of the stones.

A free copy of Report of Investigations 4853, "Diamond Orientation in Diamond Bits—A Method of Identifying Hard Vectors for Setting Purposes," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

Machine-Tool Industry

CONTINUING recognition by Congress, by administrative branches of Government, and by the Armed Services of the vital importance of the machine-tool industry as the basic foundation of national defense is the nation's most urgent need in the field of long-term defense planning, Frederick S. Blackall, jr., Fellow ASME, president and treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I., and president, of the National Machine Tool Builders' Association, stated in an address before the Westinghouse Machine Tool Forum held in Buffalo, N. Y.

The problem, Mr. Blackall said, is not a simple one. No machine-tool stock-piling program, for example, can be effective, if not indeed detrimental to our economy, unless it includes detailed and wise procedures which will keep the reserve up to date and yet dispose of the periodically discarded surplus without at once prostrating the machine-tool builder, and foisting unused and nevertheless obsolete machine tools upon American industry. But it seems obvious that the establishment of some sort of a permanently operating national machine-tool reserve program is essential to our security. In an atomic age, time may not always be on our side, he said.

According to Mr. Blackall, a stand-by plan of priorities should be enacted to provide for men, money, materials, and manufacturing—which could be invoked by executive order upon a moment's notice in time of need—a D-Day program to be kept constantly up to date—and one which will not be thrown into the discard as others have been, when the real pinch comes.

Our tax laws, now largely a hodgepodge of administrative interpretation and legislative amendment, he pointed out, need to be overhauled with a forthright recognition of what is needed to keep a strong nation strong. This will not be accomplished if political considerations catering to the weakest elements of society continue to govern our decisions.

The provision of our tax laws and regulations relating to depreciation allowances should be drawn in such manner as to stimulate rather than to discourage the constant modernization of our national industrial plant, not as an emergency measure for use only when the enemy is at the gates, but as a permanent cornerstone of tax policy. The shortsighted and arbitrary Internal Revenue restrictions which now prevent recovery, within a reasonable period, of capital invested in productive equipment, and in some cases prevent its recovery at all, should be removed without delay.

If we are to remain industrially robust, there also must be a greater recognition, in our tax policy, of the special problems and special needs of highly cyclical industries.

These, Mr. Blackall said, are but a few of the things which need to be done if our nation is to achieve its potential destiny.

Lunar Reflection

A RADIO message was transmitted for the first time by lunar reflection during a recent co-operative experiment conducted by the National Bureau of Standards and the Collins Radio Company. On Nov. 8, 1951, ultrahigh-frequency signals that had been reflected from the moon were received by the NBS field station at Sterling, Va., after having been transmitted from Cedar Rapids, Iowa.

Radio waves had been reflected from the moon before, but they were usually received at or near the point of origin. In the NBS-Collins experiment, on the other hand, the signals were transmitted so as to be received at a site 775 miles from the transmitter after reflection from the moon. The operating frequency was 418 megacycles, generated by a 20-kw transmitter. Because the transmitting antenna in Cedar Rapids was a fixed structure, lunar reflection could be accomplished only while the disk of the moon was in the beam of radio energy (a period of approximately one-half hour). The antenna at Sterling could be rotated and turned in the direction of maximum signal strength.

Reflection of the signals apparently began as soon as the leading edge of the lunar disk entered the radio beam. The receiving antenna was rotated until the maximum signal strength

was obtained—in a position pointing directly toward the moon. As the moon continued to move across the radio beam, the received signal strength increased. About 10 minutes after the initial contact, the signal strength reached its highest value. The operators in Cedar Rapids then hand-keyed the signal in Morse Code and transmitted the historic message "What hath God wrought!" The intensity remained at this maximum level for another ten minutes and then began to decrease as the moon passed out of the radio beam. The greatest signal strength received was about one millionth as strong as the signal received by most commercial television receivers.

To verify the fact that the signal was reflected by the moon, the actual transmission delay was compared with the theoretical value. This value was determined from the geometry of the experiment—the relative positions of the transmitter, the moon, and the receiver—and the known speed of radio waves. The 2.5-sec time interval that was measured agreed approximately with the theory.

The NBS-Collins experiment thus provides additional information confirming the possibility that the moon can be used as a reflector for short-wave radio transmission during those times it would be in the proper position for reflection. Use of the moon as a reflector would have the advantage that the transmissions would be free from interruption. In present long-range communications, the ionosphere is used as a reflector. This layer of electrically charged air, 100 to 350 kilometers above the earth's surface, sometimes undergoes radical changes during "ionospheric storms." When this happens, the long-range communication is partially or completely interrupted. If UHF were used, however, employing the moon as a reflector, these radio storms would have little effect on radio transmissions. Moreover, the moon would not have to be optically visible to act as a reflector, as clouds or other meteorological conditions do not affect the radio beam seriously.

As a result of these experiments, it is believed that a dependable radio system may be possible if the transmitter and receiver were engineered for the specific purpose.

Underwater Sound Signals

THE Navy has acquired basic patent rights to SOFAR (sound fixing and ranging), a development which allows underwater sounds to be picked up more than 3000 miles away.

The Navy Bureau of Ships said that SOFAR may be adopted for search and rescue operations. Tests under way in the Pacific to evaluate it should be completed this month.

If SOFAR is adopted for search and rescue work, life rafts and aircraft will be equipped with small bombs. Dropped overboard, these bombs will sink to proper water depths and explode. Sound waves thus released will be picked up by Navy SOFAR stations and positions of craft will be determined by triangulation.

Possibility of adapting SOFAR to search and rescue operations came as the result of research done by Dr. Maurice Ewing of Columbia University. While working on submarine detecting methods under a Navy contract at the Woods Hole, Mass., Oceanographic Institution, Dr. Ewing developed the principles and equipment used in SOFAR.

He found that there is a natural sound channel deep in the ocean which may be used for transmitting audible signals over great distances.

Center of this sound channel is roughly 4200 ft below the surface of the Atlantic and somewhat higher in the Pacific. It is established by a combination of temperature and water-pressure factors.

Sound waves bend toward the region where they have the lowest velocity. Velocity of sound waves under water is affected by both temperature and pressure. Higher temperatures, as well as higher pressures, increase velocity.

At depths above 4200 ft in the Atlantic, the temperature factor is dominant. Sound waves in that area bend downward toward the lower temperatures where they will travel more slowly. At depths below 4200 ft the pressure factor is dominant and sound waves at those depths bend upward.

Thus at 4200 ft the pressure and temperature factors create a region of minimum sound velocity. A large part of any sound originating at this depth is, therefore, carried along this channel for great distances without hitting the ocean surface or bottom. It thus avoids high losses due to reflection, absorption, and scattering.

Among the important features of the discovery is that sound signals on this channel can be distinguished from various other sounds which may occur in the ocean, Bureau engineers said.

TV Film System

A GLIMPSE into the future of television was provided by the Television Transmitter Division of Allen B. Du Mont Laboratories, Inc., in unveiling a revolutionary new 16-mm film system for television broadcasting at the recent convention of the National Association of Radio and Television Broadcasters, in Chicago, Ill.

Excellent pictures were shown on a developmental model of the equipment which was outstanding in its simplicity of method for handling film for television.

According to the company, this system will be commercially available in from 18 to 24 months but has been announced in order that broadcasters preparing to build TV stations upon the recent lifting of the FCC "freeze" may plan their new stations soundly, without fear of obsolescence.

The system combines for the first time the manifold advantages of the flying spot scanner television system with continuous motion film in a package for use by the commercial television broadcaster.

Advantages of the continuous motion mechanism for the film cited by the company, are as follows:

There is no intermittent movement of the film, no jerking or tearing or wearing away by intermittent sprockets or claw mechanisms. The mechanism may be run at variable speeds within the limits of the sound system. It may be stopped for single-frame operation and requires no phasing to the sync generator or power line. The pictures obtained by this method are crisp and clear and fully gamma-corrected for the entire gray scale. As compared with the overhead and operation problems of skilled iconoscope operators, this system requires no operator for shading adjustments.

A further advantage to the new Du Mont system is that it automatically provides for expansion to any color system which may be adopted later because of the nonstorage nonregistry characteristics of the flying spot system. Three simultaneous color signals may be obtained for use with any color system.

In addition, the flying spot scanner-continuous motion film system can be used as a film recorder. Raw film stock can be run through the mechanism to record pictures from the face of the cathode-ray tube. With rapid film-process equipment, it was pointed out, the system may conveniently provide the equipment required for delayed broadcast simply at each local TV station in a manner similar to the way a tape recorder does today. This can mean a big saving in recording equipment for station owners. This reverse feature will be further developed, Du Mont engineers said, when the demand for these facilities made possible by the mechanism arises.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Gas-Turbine Power

Comparative Performance of Coals of Different Rank in a Film-Cooled Gas-Turbine Generator, by T. E. Warren, H. P. Hudson, J. D. Robertson, Jun. ASME, and J. C. Mulligan, Department of Mines and Technical Surveys, Canadian Government, Ottawa, Can. 1952 ASME Semi-Annual Meeting paper No. 52—SA-4 (in type; to be published in Trans. ASME).

DEVELOPMENT of a combustor adapted to a coal-burning gas turbine for locomotive use was undertaken for the Locomotive Development Committee by Battelle Memorial Institute some years ago. The coal used in the course of this development was from Ohio No. 8 seam, and no systematic study was made of the effect of variation of coal properties on combustor performance. This phase of the general investigation was undertaken by the Fuels Division of the Mines Branch, Department of Mines and Technical Surveys at Ottawa, Ontario, Can. The present paper gives a report on 23 coals of various groups within the bituminous class of the ASTM classification by rank.

It was found that efficiency of combustion in a film-cooled combustor of a type proposed for use in coal-fired gas-turbine locomotives varies greatly with change in coal rank. The present tests indicate that bituminous coals of the high-volatile A, B, and C groups will, in general, give satisfactory performance. Coals of higher rank appear to be unsuitable because of low combustion efficiency. Tabulation of the coals tested in order of efficiency placed them in descending order of rank.

A definite trend toward higher efficiencies with higher volatile contents and high volatile heat contents is evident from the test data. Therefore one can safely say that coals of low rank, high calorific value, volatile and high volatile content will prove satisfactory in a combustor of this type operated at atmospheric pressure.

To get satisfactory combustion of the higher-rank lower-volatile coals modification of the burner design appears to be necessary. Some increase in efficiency can be expected by operation under pressure but for efficiencies constantly in the 85–95 per cent range over the full range of North American coals considerable modification will be required. This may be expecting too much of any given combustor when one considers that any other existing combustor is designed to burn fuel falling in a comparatively narrow band of variable properties.

Design Considerations and Development of a Broad Range, High-Efficiency Centrifugal Compressor for a Small Gas-Turbine Compressor, by Ivan E. Speer, AiResearch Manufacturing Company, Los Angeles, Calif. 1952 Semi-Annual Meeting paper No. 52—SA-14 (mimeographed).

THE compressor requirements for a small gas-turbine compressor unit imposes factors with regard to broad flow range and efficiency that form the basic objectives for the design and development. Highly backward-curved impellers, designed according to the reasoning presented, are shown to evidence the required characteristics. Results of the development program show that the objectives can be met and exceeded.

Work on auxiliary power units of the gas-turbine type was started by the author's company in June, 1946, under the sponsorship of BuAer. At first it was thought that the only type needed was the constant-speed-shaft power machine, originally for 50 hp output and later increased to adequate power to handle a 40-kva alternator. However, the problem of starting turbojet and turboprop engines became more important as the starting power requirements began to get higher than could be handled by electric starters of reasonable size and weight. This led to interest in the pneumatic starter which AiResearch also undertook to develop under BuAer contracts. To make the air starter practical it was necessary to have a small and lightweight source of compressed air. For this reason, emphasis was put on the development of a gas-turbine compressor (designated GTC) from which all of the useful output was taken in the form of compressed air from the compressor of the base machine. Both the gas-turbine compressor (GTC) and the gas-turbine power (GTP) versions of the unit developed for BuAer have now gone into production.

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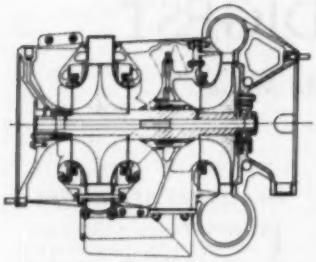


CROSS SECTION OF THE FINAL COMPRESSOR CONFIGURATION

In May, 1948, the Equipment Laboratory of AMC became interested in the GTC type units as ground, air-transportable support equipment for aircraft. The type of equipment required by AMC took a variety of configurations and variants of purpose, but their studies indicated that most if not all needs could be satisfied by one GTC, to be used singularly or in multiples as required. Review of the equipment in the field showed that there was no unit available that fitted ideally into the line of equipment contemplated. The early GTC unit developed for BuAer appeared to be small, but was utilized as interim equipment for a large-capacity ground heater (Model GH4) which delivers 4 million btu per hr at —65 F and is currently in production. Accordingly, AMC sponsored a development for a unit designed to more ideally meet their projected needs. This GTC not only was to have a somewhat higher through-flow rate but also was specified so as to require considerably higher performance components than were available in this class of equipment at that time. This development was undertaken by the author's company and the compressor, developed as a component for the Air Force Type F2 Gas-Turbine Compressor Unit (Model GTC85), is the subject of this paper.

Industrial Instruments

A Systematic Design Approach Using Block-Diagram Analysis, by John M. Embree and Stephen P. Higgins, Jr., Jun. ASME, Minneapolis-Honeywell Regulator Company, Brown Instruments Division, Philadelphia, Pa. 1952 ASME Semi-Annual Meeting paper No. **52—SA-23** (mimeographed).

THIS paper demonstrates a systematic design approach of special interest to those engaged in the design of precision devices. Complete devices are reduced to fundamental design components and the relation of the component characteristics to the device characteristics is analyzed using block diagrams. The usefulness of this approach for visualization, organization, and cataloging of information is illustrated by means of typical examples.

The design of complex precision devices for quantity production raises many problems. Such devices are rarely the work of a single designer, but usually involve as well the co-ordinated efforts of many specialists with different technical backgrounds. Familiar components must be used most effectively and it is often necessary to develop or purchase new components in order that the over-all device meet specifications. Since device performance depends critically on certain components, it is essential that the individuals involved have a full appreciation of the over-all problem. Further, it is essential that the details not be obscured by the over-all problem.

Although the use of blocks to designate components of systems is well known, the writers believe that heretofore the potentialities of the method as a design tool have been only partially developed. It is standard practice to draw a detailed block diagram of a system, combine the blocks, then describe over-all system performance by means of the more compact block diagram. However, the basic components may be quickly buried in expressions and transfer functions which lend themselves to generalized analysis, but suffer from losing their individual identities. This paper purports to show that from the viewpoint of the designer or specialist much is to be gained by reducing a device to basic blocks by a process just reverse to the usual one of combination.

Lubrication

On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—II, the Viscosity a Function of the Pressure, by A. Charnes and E. Saibel, Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1952 ASME Semi-Annual Meeting paper No. **52—SA-2** (in type; to be published in Trans. ASME).

THE solution of the Reynolds equation for slider-bearing lubrication is given for the finite bearing, side leakage included, when the viscosity is a known function of the pressure. The solution for the pressure distribution is obtained readily from the corresponding case of constant viscosity. The design factors—total load, center of pressure, friction force, and side leakage—also may be obtained, but, in general, the integrals involved must be worked out numerically. Qualitative properties of the pressure, total load, and center of pressure are obtained.

Heat Transfer

Local Coefficients of Mass Transfer by Evaporation of Water Into an Air Jet, by Maurice Spielman, Jun. ASME, and Max Jakob, Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1952 ASME Semi-Annual Meeting paper No. **52—SA-1** (in type; to be published in Trans. ASME).

A PREVIOUS paper dealt with the heat transfer in the flow of an air jet parallel to a plane plate. The present paper reports on experiments on evaporation from wet porous plates to such a jet. A satisfactory correlation of a modified Nusselt number with a Reynolds number and a starting-length function is presented. The influence of the starting points of hydrodynamic, thermal, and diffusional boundary layers is discussed, with reference to previous work on the subject.

Joule-Thomson Coefficients for Air at One Atmosphere, by J. H. Potter, Mem. ASME, and L. N. Tao, University of Illinois, Urbana, Ill. 1952 ASME Semi-Annual Meeting paper No. **52—SA-9** (mimeographed).

THE object of this investigation was to collect and correlate data on the Joule-Thomson coefficient for air at one atmosphere, and over a range of temperatures. Both analytical and experimental values were considered.

At one atmosphere, and between 160 K and 360 K a satisfactory equation was found in the form

$$\mu = 2.4512 - 0.017498\,(T) + 4.7708(10)^{-5}(T)^2 - 4.6875(10)^{-8}(T)^3$$

where T is in degrees Kelvin and μ is in degrees Centigrade per atmosphere.

Railroads

Effect of Impact on Freight-Operation Loss and Damage, by W. A. Murphy, The New York, Chicago & St. Louis Railroad Company, Cleveland, Ohio. 1952 ASME Semi-Annual Meeting paper No. **52—SA-26** (mimeographed).

ACCORDING to this paper the aggregate Loss and Damage Claim Bill for United States and Canadian Railroads the three years, 1948 through 1950, approximated $338,192,076. (Complete figures for 1951 are not available.)

Overspeed impacts and improper handling of cars were partly responsible for over $231,500,000, or about 68½ per cent of this staggering waste. Included in this classification is Located Damage, Unlocated, and Concealed Damage; only part of this is spelled out in claim statistics as specifically charged to rough handling of cars in yards and trains, for the reason payments are placed in this latter category only when the evidence is unmistakable. There is another 4 to 5 per cent damage caused by defective or unsuitable equipment, defects to doors, floors, walls, roof panels, allowing rain, snow, cinders, and other damaging matter to enter, and this also is specifically allocated only when the cause is unmistakable. This huge sum, large as it is, does not begin to tell the complete story because it does not include the cost of damage to equipment or related losses that occur when cars are taken out of revenue service undergoing repairs on rip tracks; neither does it include many miscellaneous expenses that the carrier and patron sustain when transportation and equipment failures result in freight shipments becoming damaged while in the custody of the carriers. There are other immeasurable losses that arise when shipments or parts thereof are removed from the normal channels of industry, such as dissatisfied customers and diversion of traffic to other forms of transportation.

Petroleum

The Distribution of Mechanical and Thermal Stresses in Multilayer Cylinders, by R. A. Strub, E. I. du Pont de Nemours & Company, Inc., Charleston, W. Va. 1952 ASME Semi-Annual Meeting paper No. 52—SA-5 (mimeographed).

THE tendency in the chemical industry to operate processes under higher and higher pressures has forced the designer to devote more attention to the design of pressure vessels and to diminish the factor of safety. The stress distribution due to pressure in the wall of high-pressure vessels is very uneven, and the optimum utilization of the material is far from being reached. Different modifications have been proposed in the past to overcome this difficulty. It is possible to obtain a better distribution of stress by introducing an adequate field of residual stresses. This can be accomplished by autofrettage producing partial or total yielding of the wall of the vessel.

Alternatively, a field of initial stress can be introduced by shrinking several cylinders or layers one upon the other. If the number of layers is large and their thickness relatively small, the vessel can be built by wrapping a sheet or strip of steel round a cylindrical core. Well-known examples of this type are the A. O. Smith vessels and the German design utilizing interlocked narrow steel strips. This last type of vessel has the advantage of allowing the use of steel bands which can be evenly heat-treated to maximum strength and inspected for soundness.

In this paper, relations for the optimum proportions of multilayer vessels and the computations of stresses are derived. They are based on the energy-of-distortion strength theory which is discussed and illustrated by a photograph of a model. It is shown that the stress distribution in fully or partially plastic cylinders can be obtained as the limit case of a multilayer vessel with an infinite number of layers of constant or variable yield point. Relations are proposed for the determination of the plastic strains. The problem of thermal stresses is discussed and a graphical method for the rapid computation of transient thermal stresses is explained.

Fuels

Design and Construction of Pacific Gas and Electric Company's 34-In. Gas Line, by John J. Pugh, Pacific Gas and Electric Company, San Francisco, Calif., Ray L. Hamilton and Richard Finnie, Bechtel Corporation, San Francisco, Calif. 1952 ASME Spring Meeting paper No. 52—S-22 (mimeographed).

NOW delivering 400 million cu ft of natural gas every day to meet the growing needs of Central and Northern California, the greatest pipe line of its kind in the world was recently completed by the Pacific Gas and Electric Company. Tying in with feeder lines from sources in West Texas and New Mexico, the "super inch" is 502 miles long and 34 in. in diameter. It starts near Needles, on the California side of the Colorado River opposite Topock, Ariz., and ends at Milpitas, at the southern end of San Francisco Bay.

The pipe line has a tapered wall thickness and is powered by three gas-engine-driven reciprocating-type compressor plants, located at Topock, Hinkley, and Kettleman. The Topock compressor station, with 15,000 bhp installed, is located at the beginning of the pipe line on the California side of the state line. The Hinkley station, with 17,500 bhp installed, is 159 miles west of the Topock station. The Kettleman station, with 12,320 bhp installed, is 195 miles northwest of the Hinkley station. The total installed bhp at the three stations is 44,820 and the size of the compressors in these plants varies from 1320 to 2500 bhp.

At the outset it was decided to design a pipe line wherein the wall thickness would be tapered. The wall thickness was varied to the nearest $\frac{1}{32}$ in. along the route and pressure-limiting stations were installed at points where the wall thickness was reduced. Pressures would be controlled at the pressure-limiting stations so that the pipe on the downstream side of the station would not be subjected to a greater working pressure than the maximum allowed for the wall thickness used in the section downstream of the stations. Tapering the wall thickness of a pipe line is a means of taking advantage of the natural decline in the pressure gradient to effect a substantial saving in steel tonnage and a corresponding saving in first cost. For the 34-in. Topock-Milpatas pipe line the saving in tonnage from tapering the pipe line, as opposed to installing a line of uniform $\frac{7}{16}$-in. wall is 28,000 tons. This represents a saving of over 15 per cent in pipe tonnage requirements, or approximately $4 million in out-of-pocket cost.

A detailed investigation of the balance between brake horsepower, pipe diameter, pipe tonnage, number of compressor stations, and the corresponding annual cost was undertaken before the pipe size and number of compressor stations for this pipe line were chosen. All studies were made for an end delivery of 420 million cu ft per day. The pipe diameters ranged from 30 to 36 in. and the total number of compressor stations for the project was varied from two to four.

In addition to exploring the cost relation of capacity versus the number of compressor stations on the pipe line, the economics of varying the starting wall thickness at each compressor station was reviewed.

A Study of Detonative Phenomena in Gaseous Mixtures by the Use of Shock-Tube Techniques, by Richard B. Morrison, University of Michigan, Ann Arbor, Mich. 1952 ASME Semi-Annual Meeting paper No. 52—SA-20 (mimeographed).

THE normal combustion of homogeneous gas mixtures occurs at a rate which is largely governed by the multiple-diffusion processes within and in the neighborhood of the flame front. These processes are leisurely and the propagation rates associated with such combustion are on the order of a few feet per second. Under certain favorable conditions, however, combustion waves develop which possess the extraordinary

velocities of several times the speed of sound. This phenomenon, or "detonation" may be regarded as a shock wave followed by combustion, the combustion being initiated by the high temperatures accompanying the shock rather than by the diffusion processes just mentioned.

Most of the theoretical investigations of detonation treat the thermodynamic aspects of the process with attention being focused on state changes across the wave. The significance of the dynamic aspects of the wave is obscured by the elimination of velocity terms in the conservation equations. It is the purpose of this investigation to point out the functional dependence existing between the thermodynamic properties and the dynamic properties of a detonating mixture.

The detonation of various fuel-oxygen and fuel-air mixtures is precipitated in a shock tube by means of shock waves.

It is concluded that analyses of detonation waves which connect the dynamic properties of the waves to the thermodynamic properties can be made which are in good agreement with experiment. From these analyses a heating parameter is indicated which would correlate all experimental detonation velocities when such velocities are expressed in terms of the Mach number of detonation. The latter correlation is borne out by the experimental investigations. Spark Schlieren photographs of hydrogen-oxygen detonations indicate the existence of flow instabilities for the case of lean detonating mixtures.

Field Tests of Oil and Gas Residential Space Heating, by A. L. Carroll, Consolidated Edison Company of New York, Inc., Mount Vernon, N. Y. 1952 ASME Semi-Annual Meeting paper **52—SA-21** (mimeographed).

THIS report covers the fuel usage for an entire heating season of 51 residences in Westchester County (a suburb of New York City) utilizing domestic fuel oil and 56 residences in the same area utilizing manufactured gas for space heating. Suitable corrections have been made for variations in house construction, insulation, temperature, and other factors in order to arrive at a common factual relationship between the two fuels.

These tests are based upon manufactured gas of 537 Btu per cu ft but all results are reported in therms (100,000 Btu).

Aim of the project was to establish a quantitative relationship between the gallons of fuel oil and cubic feet of 537 Btu gas or therms required to do a given heating job. By way of further clarification, it should be stated that the significant point in this whole question was the actual usage of gas and oil in the average home during a normal heating season and not efficiencies determined either in a laboratory or in a test residence under controlled conditions.

The final results of the tests were that in a normal heating season of 5090 degree-days, the fuel requirements per 1000 Btu heat loss, were found to be:

1 For gas, 4123 cu ft of 537 Btu manufactured gas or 2100 cu ft of 1055 Btu natural gas or 22.14 therms.

2 For oil, 22.5 gal or 31.5 therms

This relationship shows that domestic oil-burning heating equipment is on the average only 70.3 per cent as efficient as gas-burning equipment based on normal seasonal use, or that 43 per cent more fuel heat units are needed to do the same heating job by oil than by gas.

Design, Installation, Application of Fuel-Burning Equipment for 25 to 500 Hp Range, to Prevent Air Pollution, by C. W. Gruber, Bureau of Smoke Inspection, City of Cincinnati, Cincinnati, Ohio. 1952 ASME Semi-Annual Meeting paper No. **52—SA-22** (mimeographed).

THIS paper deals primarily with the small plant in the 25- to 500-hp range. This range should probably be referred to as the smaller plants, as compared with power plants of capacities less than 250,000 lb of steam per hr and identified as a small power plant. It is in this smaller range that we often find boiler plants being assembled by plant management without the assistance of the professional design engineer. It is not implied that staff engineers are incapable of assembling a working boiler plant. That is not the case. However, the smaller the plant, the more varied are the duties of the responsible plant engineer, and the time required to properly fit one piece of equipment to another and the whole boiler plant to the service demanded is frequently lacking, so that important details are often missed.

Many papers have been written on the positive approach, that is, the step-by-step selection of equipment to fit the job. Many recipes for a successful job can be found already in print. This paper discusses actual cases in which some details were overlooked, and thereby left a trail of smoke which brought in the city smoke inspector to haunt the plant manager until the job was finally ironed out.

Hydraulics

Some Investigations With Wet Compression, by J. T. Hamrick and W. L. Beede, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1952 ASME Semi-Annual Meeting paper No. **52—SA-15** (mimeographed).

THERE are many problems associated with wet compression, however, the potentially large increase in compression ratio which may be obtained with little or no increase in work input to the compressor makes the use of wet compression quite attractive.

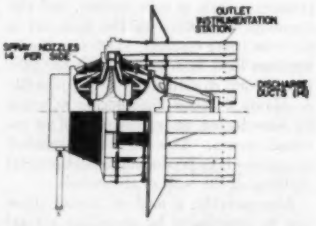
This paper presents the results of some experimental investigations on several centrifugal-flow compressors using water injection. In addition, mechanical considerations, special instrumentation, and theoretical aspects are discussed and a method of computing adiabatic efficiency with wet compression is presented.

In general, it was found that the injection of liquids at the inlet to a compressor shows promise of increasing the pressure ratio obtainable for a given work input. However, the increase in pressure ratio may be offset by a decrease in cycle efficiency with a consequent increase in specific fuel consumption.

For momentary augmentation of normal power, liquid injection is practical on engines using compressors designed for dry compression, but for continuous operation with wet compression specially designed compressors are necessary.

It appears from the evidence available that the main source of evaporation of the injected liquid was from the wetted surfaces in the compressors investigated. It is probable that the adiabatic efficiency could be increased if vaporization from droplets homogeneously mixed with the air could be achieved.

Generally, when water is injected into a compressor, increases in both maximum and minimum (surge) weight flows are obtained. It is possible to render an engine inoperable with the injection of water due to the shifting of the compressor surge point.



TYPICAL CENTRIFUGAL COMPRESSOR USED IN INVESTIGATION OF WATER INJECTION

Excessive pitting of aluminum-alloy blades occurs for continuous operation with water injection.

When hard water is injected into a compressor, a heavy layer of minerals is rapidly deposited on compressor outlet surfaces.

Theoretical calculations show that for pressure ratios less than 8, water-air ratios greater than 0.05 are relatively ineffective.

Cutting Fluids

Definitions, Functions, Types, and Designations of Cutting Fluids, by O. W. Boston, Fellow ASME, University of Michigan, Ann Arbor, Mich. 1952 ASME Semi-Annual Meeting paper No. **52—SA-13** (mimeographed).

FOR the past several years two committees have been working on the standardization of Definitions, Functions, Types, and Designations of Cutting Fluids with the hope of arriving at terms which can be used by both the oil chemists and production men so as to avoid misunderstandings, and at the same time, present the clear simple truth of the subject matter. The material given in this paper has been approved both by the Research Committee on Cutting Fluids of the ASTM and the ASME, and is presented for the purpose of bringing it to the attention of more people interested, and at the same time, inviting comments from those wishing to improve this standard.

Management

The Role of the Estimator in Industry, by W. A. Nordhoff, Douglas Aircraft Company, Inc., Santa Monica, Calif. 1952 ASME Spring Meeting paper No. **52—S-16** (mimeographed).

PRODUCTION estimates, as used in the Douglas Aircraft Company, must be highly refined. They must be as nearly correct as it is humanly possible to make them. When they are used as a measure of operator effectiveness, when men are judged and rated by them, it is paramount that weight be given to every time-consuming factor. It would be manifestly unfair to the operator if little thought were given to the estimate.

It has been found that the most accurate method of estimating is to make as fine an elemental breakdown of the job as possible and to place time values upon these elements. The time on any single element will be small. Therefore any error on the part of the estimator in giving it a time value will be small. Errors in judgment will be made on both sides of the ledger in normal estimating. Some elements will be overestimated; others will be underestimated. The errors on the plus side and those on the minus side will tend to offset each other. This makes it possible for the over-all estimate to be near right.

The estimate not only tells the worker what is expected of him for the wages he receives but also tells the company what it has a right to expect. The estimator thus keeps alive the principle of fair play between employee and employer. The company pays for a day's work and has a right to expect a reasonable day's effort for that pay. The worker also believes in fair play. He wants to do a fair day's work for the wages he receives. The estimate tells him what his employer feels to be a standard of fair play. The estimator in this respect acts as the balance between the employer and sets that standard. The estimator, at all times, should be observing and critical of method. His position in the plant affords him the greatest opportunity for constructive creative work. The shop is the analyst's paradise.

The estimate must be a production standard for the normal average worker. It must be readily attainable by him. The first-class worker will better the estimate by a considerable margin. The estimate should not be something arbitrary and mysterious. It should be open at all times to review. Any operator who charges the standard as being too low is entitled to a review of that standard and to an immediate revision in his favor should the facts warrant it. One justified revised standard in favor of the worker is worth a thousand protestations of interest in fair play.

Applied Mechanics

Torsion of a Circular Shaft With Diametrically Opposite Flat Sides, by W. J. Carter, Mem. ASME, and J. B. Oliphint, University of Texas, Austin, Texas. 1952 ASME Spring Meeting paper No. **52—S-2** (in type; to be published in the *Journal of Applied Mechanics*).

THE solutions for torsional stress and torsional stiffness of circular shafts with flat sides which are presented in this paper have been obtained by means of the relaxation technique. The solutions for both shear stress and torsional stiffness are given for four ratios of flat side dimension to diameter of the shaft. The stress for a very small flat has been obtained by use of a hydrodynamic analogy to the torsion problem. A comparison of the results obtained is made with those given by Okubo.

On the Stresses in a Notched Strip, by Chih-Bing Ling, Aeronautical Research Laboratory, Taiwan, China. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-5** (in type; to be published in the *Journal of Applied Mechanics*).

IN a previous paper by the author, a theoretical solution for a notched strip under longitudinal tension is given. The result demands the solution of an infinite system of linear equations. A considerable amount of labor is involved in solving such a system. It seems, however, that the labor can be diminished by adapting to the solution a process known as the promotion of rank. In this paper such a process is described and then applied to solve the problem of a notched strip under transverse bending. The solution of this problem seems also to be new. The numerical results obtained are compared graphically with the experimental results available.

On the Stresses in a Rotating Disk of Variable Thickness, by Ti-Chiang Lee, Aeronautical Research Laboratory, Taiwan, China. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-6** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper presents an analytic solution of the stresses in a rotating disk of variable thickness. By introducing two parameters, the profile of the disk is assumed to vary exponentially with any power of the radial distance from the center of the disk. In some respects this solution may be considered as a generalization of Malkin's solution, but it differs essentially from the latter in the method of solution. Here, the stresses are solved through a stress function instead of being solved directly. The required stress function is expressed in terms of confluent hypergeometric functions. Numerical examples are also shown for illustration.

An Airy Integral Analysis of Beam Columns With Distributed Axial Loading Having a Fixed Line of Action, by C. M. Tyler, Jr., Jun. ASME, Carnegie Institute of Technology, and J. G. Christiano, University of Pittsburgh, Pittsburgh, Pa. 1952 Applied Mechanics Division Conference paper No. **52—APM-8** (in type; to be published in the *Journal of Applied Mechanics*).

AN analytic method of solution of beam columns with partial uniformly

distributed axial loading whose line of action does not change as the column deflects is developed in terms of Airy integral functions. This method is valid when the beam bending moment can be expressed or approximated piecewise as a polynomial. A numerical example is included and also tables of the necessary Airy integral functions and their first derivatives.

Torsion of Uniform Rods With Particular Reference to Rods of Triangular Cross Sections, by Henry Nuttall, The University, Birmingham, England. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-27** (in type; to be published in the *Journal of Applied Mechanics*).

A SOLUTION of the Saint Venant torsion problem is presented which is alternative to that usually adopted. When the cross section has the shape of an isosceles triangle the method also provides a close and useful Rayleigh-Ritz solution. The torsional rigidity has been evaluated for a range of section proportions, and simple expressions for an approximate evaluation of the maximum shearing stress are provided. Use is made of the hydrodynamic analogy to extend the application of these solutions to the problem of the flow of a viscous incompressible fluid in a tube of triangular section.

Investigation of Annular Liquid Flow With Concurrent Air Flow in Horizontal Tubes, by A. E. Abramson, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-11** (in type; to be published in the *Journal of Applied Mechanics*).

VISUAL observations and flow analysis were made of annular liquid flow with concurrent air flow in horizontal tubes. The effect of liquid properties and air-stream conditions on the characteristics of the liquid flow were observed. The results are presented in form of shadowgraph pictures of the liquid flow. Analysis of the flow system related the characteristics of the liquid flow to the flow conditions.

Pressure Drops in the Pneumatic Conveyance of Solids, by Oscar Pinkus, Jun. ASME, General Electric Company, Schenectady, N. Y. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-30** (in type; to be published in the *Journal of Applied Mechanics*).

WITH the object of studying the characteristics of the horizontal flow of a mixture of solids and air a theoretical analysis of the flow pattern was attempted. Experiments were performed whose object was to determine the relationship between pressure loss, solids flow rate, and air velocity, and to obtain values for the frictional constants involved in the analysis. A justification for the developed equations was sought. It was found that the presence of the solid phase causes an appreciable pressure loss which is a linear function of both solid and gas flow rate. This justified the theoretical equations which predicted such a relationship. Experiments with two sizes of the same sand showed a higher pressure drop for the larger particles, other conditions being equal. These experiments, however, question the validity of applying the Fanning equation to a solid phase. The equation holds for a given solid but does not take into account variations in its size. The introduction of the dimensionless group d/D is proposed. On the basis of this investigation, it is concluded that the drag coefficient C is a function of the Reynolds number. The ratio of solids velocity to gas velocity is 0.5-0.6 for the small and 0.3 for the large sand. Following results of this work it would seem desirable to operate pneumatic systems at low gas velocities and high solid rates. Recommendations for further investigations are made.

Optimum Single Propellers in Radially Varying Incompressible Inflow, by Frank Lane, The Pennsylvania State College, State College, Pa. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-23** (in type; to be published in the *Journal of Applied Mechanics*).

THE Betz process for minimizing the energy loss of single propellers is extended to the propeller operating in radially varying inflow, with a view toward the development of optimum stern propulsion for bodies of revolution. Assuming the usual lifting-line treatment of the propeller blades, an application of the isoperimetric problem in the calculus of variations is directed toward minimizing the energy loss while maintaining constant total thrust. Resulting expressions describe the optimum radial distribution of induced velocity in terms of an undetermined multiplier. The magnitude of the required total thrust, in turn, fixed the value of this multiplier, making the solution determinate. Inclusion of blade-profile drag at a later point in the development serves to determine an optimum propeller diameter for minimum over-all energy loss. The method gains in accuracy as the ratio of blade number to advance ratio increases, due to an approximation in the relation between the circulation and induced velocity.

A Progressive-Wave Approach to the Theory of Blast Shock, by R. G. Newton, Harvard University, Cambridge, Mass. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-18** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper deals with a theoretical description of the motion of a spherical shock wave in a homogeneous medium, such as a blast shock in free air. In order to facilitate such a treatment a simple assumption concerning the flow is made. The concept of a "progressing wave" as used in this paper is explained and compared with that used by other authors. A simple assumption is made about the motion of the progressing wave, and on its basis an ordinary second-order differential equation for the shock front is derived. Conservation of energy in the shock sphere reduces this to an ordinary first-order differential equation. Examination of the asymptotic behavior of the wave reveals that the original assumption in its simplest form contradicts conservation of energy. The original assumption is then suitably modified and the resulting new equations derived, including asymptotic values. Values for the high-pressure approximation, i.e., near the center of the explosion, are derived, and finally asymptotic as well as high-pressure values are derived for the pressure decay behind the shock front.

Bending of Elastoplastic Circular Plates With Large Deflection, by P. M. Naghdi, Jun. ASME, University of Michigan, Ann Arbor, Mich. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-16** (in type; to be published in the *Journal of Applied Mechanics*).

A GENERAL theory for the elastoplastic bending of thin circular plates with polar symmetrical loading is developed, and a numerical integration method is given for the complete solution of problems within the scope of the general theory. In the development of the theory, stress-strain relations of the deformation type (theory of plastic deformation) are employed. As special examples, simply supported circular plates with a central concentrated loading are considered. Using a stress-strain curve for 24S-T aluminum which is determined experimentally, numerical solutions for bending moments, membrane forces, and deflections are obtained

for two cases. In one case, the plate experiences large elastic deformation and in the second case, the plate undergoes large elastoplastic deformation. Several plate specimens, made of the same sheet of 24S-T aluminum for which the foregoing stress-strain curve was determined, are tested and a comparison is made between the theoretically determined and the experimentally obtained values of deflection.

Vibrations of Elastic Shells in a Fluid Medium and the Associated Radiation of Sound, by Miguel C. Junger, Jun. ASME, Harvard University, Cambridge, Mass. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-28** (in type; to be published in the *Journal of Applied Mechanics*).

THIS is a study of the vibrations of thin elastic shells freely suspended in a compressible fluid medium. The effect of the fluid reaction on the dynamic characteristics and, in particular, on the natural frequencies is investigated for cylindrical and spherical shells. The dynamic configuration of such shells undergoing forced vibration and the associated radiation of sound are determined. The problem is analyzed by means of the classical methods of the theory of mechanical vibrations; the Lagrange equations for the system are derived, the fluid reaction being introduced in the form of generalized forces. From the boundary condition that the normal shell deflection be equal to the normal fluid particle displacement at the shell surface, and introducing the concept of acoustic impedance, it is shown that the fluid reaction is equivalent to an accession to the inertia of the shell and to a damping force. Numerical examples show that the effect of the fluid reaction on the dynamic characteristics of a shell may be of such magnitude as to render valueless calculations neglecting it.

Bending and Buckling of an Elastically Restrained Circular Plate, by H. Reismann, Consolidated Vultee Aircraft Corporation, Fort Worth, Texas. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-7** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper considers the effect of an elastic boundary restraint upon the deflection, moments, and critical (buckling) loads of a circular plate. The solutions given are based upon the classical theory of plates and are exact within the assumptions underlying this theory. They include, as particular limiting cases, the known solutions for the simply supported and rigidly clamped edge. The physical significance of the results obtained is discussed in detail with particular emphasis upon the degree of restraint along the clamped edge.

The Marcus Method Applied to Solution of Uniformly Loaded and Clamped Rectangular Plate Subjected to Forces in Its Plane, by C. C. Chang and H. D. Conway, Jun. ASME, Cornell University, Ithaca, N. Y. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-1** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper presents a solution to the small-deflection problem of the uniformly loaded rectangular plate with all edges clamped, when the latter are subjected to uniform tensile or compressive forces in the plane of the plate. Since an exact solution to the problem is hardly possible, the Marcus method was used for the approximate solution of the biharmonic equation, subject to the conditions of zero slope and deflection at the boundary. Deflections and moments are presented for a square plate with four particular values of tensile end load, and for the rectangular plate with seven length-breadth ratios and with one value of compressive end load.

Bending of a Uniformly Loaded Rectangular Plate With Two Adjacent Edges Clamped and the Others Either Simply Supported or Free, by M. K. Huang and H. D. Conway, Jun. ASME, Cornell University, Ithaca, N. Y. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-14** (in type; to be published in the *Journal of Applied Mechanics*).

THE distribution of deflection and bending moment in a uniformly loaded rectangular plate having two adjacent edges clamped and the others either simply supported or free, are obtained by a method of superposition. Numerical values are given for square plates and, in one case, the results are compared with those obtained by another method.

Large Deflections of Circular Plates, by M. Stippes, Washington University, St. Louis, Mo., and A. H. Hausrath, Jun. ASME, University of Illinois, Urbana, Ill. 1952 ASME Applied Mechanics Division Conference paper No. **52—APM-12** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper contains a solution of von Kármán's equations for a uniformly loaded, simply supported circular plate. The method used to obtain the solution is the perturbation procedure. Series expansions for the deflection and stresses in the plate are obtained. The legitimacy of these expansions is demonstrated in the Appendix. Critical values of stress and deflection are presented in graphical form. Furthermore, tables of coefficients for the afore-mentioned series are presented if anyone desires to extend the results which are presented in this paper.

ASME Transactions for May, 1952

THE May, 1952, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Characteristics of Dished-Plate (Belleville) Springs as Measured in Portable Recording Tensiometers, by J. J. Ryan. (51—F-2)

The Theory and Design of Long-Deflection Constant-Force Spring Elements, by F. A. Votta, Jr. (51—F-11)

A Contribution to the Problem of Designing Radial Turbomachines, by O. E. Balje. (51—F-12)

Some Theoretical Aerodynamic Investigations of Impellers in Radial- and Mixed-Flow Centrifugal Compressors, by J. D. Stanitz. (51—F-13)

Single-Stage Radial Turbines for Gaseous Substances With High Rotative and Low Specific Speed, by W. T. von der Nuell. (51—F-16)

Research in Exhaust Manifolds, by P. H. Schweitzer. (51—A-132)

Operation and Performance of Modern Reheat Boilers, by P. R. Loughin and H. H. Poor. (51—A-80)

Some Design Factors Relating to Performance and Operation of Reheat Boilers, by H. H. Hemenway. (51—A-142)

A Progress Report of Reheat Boiler Design and Operation, by W. J. Vogel and E. M. Powell. (51—A-144)

Reheat Experiences at Port Washington, by M. K. Drewry. (51—A-45)

The First Year's Operation of the Dunkirk Steam Station, by J. N. Ewart. (51—A-138)

Twenty-Five Years of Reheat Operating Experience on the American Gas and Electric System, by S. N. Fiala. (51—A-70)

Operating Experience With Reheat at Edgar Station, by H. E. Stickle. (51—A-135)

Station Design With Cyclone-Fired Steam Generators, by H. C. Schroeder and R. J. Strasser. (51—A-118)

Effect of Velocity on Tensile Impact Properties of Polymethyl Methacrylate, by Bryce Maxwell and J. P. Harrington. (51—A-65)

An Investigation of Electromagnetic Flowmeters, by H. G. Elrod, Jr., and R. R. Fouse. (51—A-79)

Analysis of Some Hydraulic Components Used in Regulators and Servomechanisms, by S. Z. Dushkes and S. L. Cahn. (51—A-22)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Developments in Francis Turbines

COMMENT BY GEORGE A. JESSOP[1]

This interesting and valuable paper[2] brings the practice in the hydraulic-turbine industry up to date in an excellent manner and leaves little to be added. There are a few points in connection with welding and with welded equipment that might be brought out or further stressed.

The designer of welded elements can use higher stresses than with castings as pointed out but, in addition, he can be confident of greater reliability and uniformity as the possibility of undisclosed flaws is minimized although, perhaps, not entirely eliminated. The allowance for finish on pieces requiring machining is substantially reduced. Since for modern turbine equipment large machine tools with high hourly rates are required, important savings are realized. There is little danger of rejection during or after machining.

The cost of weldments can be computed accurately because the weight and machine hours can be figured exactly. This is an important consideration when preparing proposals for large units which almost always, at least to some extent, are novel in design and size.

As noted in the paper, there is a large saving because of the reduction in the number of patterns required. It follows that less space for pattern storage is needed. The problem of storage is a serious one for all manufacturers.

Where a portion, or portions, of a piece of welded equipment requires complicated shapes necessitating the use of dies for forming, or an assembly of small items, it is frequently economical to use steel castings for part of the assembly. The carbon content of the casting should be kept reasonably low. The cast portion can be welded to the plate without difficulty. Composite weldments of this type are used frequently.

Before proceeding with exceedingly large equipment much experience had been gained with smaller but similar welded structures. The problems involved were studied fully and the resulting designs well proved. Large welded equipment has now been tested thoroughly under actual service. At Bonneville the first two units went into service in 1937, and the last in 1943 and 1944. The stay ring, discharge ring, outer, intermediate and inner head cover, bearing housing, pit liner and draft-tube liner were all of welded construction. During the war these units were operated with the headwater elevation raised 10 ft above normal so that the turbines were under about 15 per cent higher head than that for which they were designed. Further, much of the time the units were running at the cavitation limits. The operating conditions on large adjustable-blade propeller units are such as to place the equipment under severe test. The welded components comprising the turbine distributor at many plants both of the Francis and propeller type have developed no troubles of any kind.

As noted by the author, Francis runners with plate-steel buckets welded to a steel crown and band were naturally suggested. Among the advantages are smooth surfaces presented by the prefinished crown and band as well as by the buckets, the regularity of the bucket spacing and openings and, in particular, the exact shape, diameter, and centering of the band. While it may seem now that the fabrication of these runners presents little difficulty, the first ones many years ago posed many problems. Even now great care must be used and the work competently supervised. Four such runners were made as early as 1929, and have been in successful use for upward of 20 years.

Since that time the number of welded runners has increased rapidly, one manufacturer alone having made more than 100.

Among these are one having a discharge diameter of 9½ ft and weighing 16,000 lb. There is another of 9-ft discharge diameter and a smaller one, both operating successfully under 91 ft head. Special designs and unusual care in welding are required for meeting such conditions successfully.

Eight runners with stainless-steel buckets welded to carbon-steel crown and band are in service. Two of these have discharge diameters of 9 ft and operate under 70 ft head, and two somewhat smaller ones have been operating under a range of head of 90 to 120 ft for 10 years or more.

The author calls attention to the increasing use of stainless prewelding on Francis runners. Unless unusually low-specific-speed turbines are selected or unless they are set exceptionally close to, or perhaps actually under tailwater, pitting usually develops sooner or later. Since field repairs and maintenance are expensive, the use of protective prewelding is rather rapidly spreading. This can be done more cheaply and better in the shop than in the field.

Up to the present time, more experience has been gained from adjustable-and fixed-blade propellers than from Francis runners. The protected areas on propeller runners are fairly large. After much thought and effort a method has been perfected for machine-welding these areas. The development was accompanied by tests to determine the strength of the bond, the dilution of the stainless, the hardness of the welded material, and its resistance to cavitation. Close procedure control must be exercised. Studies are being made to apply the method to Francis runners but there are exceedingly difficult problems to solve.

Small propeller runners present a special problem because of the reduced thickness of the areas to be coated and consequent warping of the parent metal. Here the solution has been found to be the use of properly shaped stainless-steel castings welded to the carbon steel of the blades, the blade castings having been properly shortened or cut back. Again, tests were made to determine the strength of the structure and resistance of the castings and the weld metal to cavitation. The stainless castings are so placed as to insure only light grinding and polishing on the area subject to cavitation, thus preserving the hard cast surface which is found to have excellent cavitation-resisting qualities.

The application of this method to

[1] Consultant, S. Morgan Smith Company, York, Pa.

[2] "Recent Developments in Francis Turbines," by W. J. Rheingans, MECHANICAL ENGINEERING, vol. 74, March, 1952, pp. 189-196 and 211.

Francis runners also presents difficult problems. In a few instances, however, field repairs have been so made.

There are many other important features and phases of the industry ably set forth and discussed, and the author is to be highly commended.

COMMENT BY H. J. PETERSEN[3]

It has been the experience of TVA that one of the tightest bottlenecks in getting a turbine on the line is the procurement of large castings. Time after time the turbine manufacturer has had to delay completion of certain parts because of defective castings. We have had experiences where three or four castings had to be made for the same part of the turbine. Also, the number of foundries capable of pouring a large-size casting seems to be very small, further limiting the output of castings. It is the writer's opinion that the turbine manufacturers can take a long step forward in turbine production if they design their machines so as to use a larger portion of steel-plate construction and eliminate almost entirely the use of castings. The author mentions this feature in his paper, but the writer does not believe the turbine manufacturers have gone far enough.

The writer also believes that some kind of impregnated metal should be investigated for turbine guide bearings. Such metals have been used successfully on smaller high-speed bearings. This would eliminate the complicated oil-pumping systems now commonly used for this purpose. These systems with their switches, alarms, d-c and a-c pump motors, and so on, get fairly complicated and are the source of some maintenance. With the advent of more and more remotely controlled plants, this feature takes on added significance.

The self-lubricated bearings mentioned in the paper may be the answer to this problem for small-diameter shafts, but something should be developed for larger diameter bearings.

COMMENT BY H. S. VAN PATTER[4]

The following comments are based on the writer's considerable experience with Francis turbines, and relate more particularly to recent Canadian practice:

Spiral-Case Construction. The information presented concerning the relative costs of large welded and cast spiral cases and the alternative methods of construction used as shown in Table 1 of the paper are of special interest. It is apparent that there is still a good deal of difference in opinion as to the most suitable type of field joints. For the same head of 330 ft the three types, flanged, riveted, and welded, are all listed.

The writer has found that the combination of shop welding and field riveting is preferred by many engineers for large, medium-head units but the all-welded construction is growing in favor. The use of a shop-welded, furnace stress-relieved connection between the plate case and the stay ring is desirable when shipping clearances permit. This design is being used for the 105,000-hp 292-ft-head turbines to be installed in Sir Adam Beck Niagara G.S. No. 2 now under construction. In this case the radial field joints will be riveted, and longitudinal field joints will be eliminated.

For the 120,000-hp 210-ft-head units under construction for the Waneta, B.C., plant of The Consolidated Mining & Smelting Company, nearly all case joints including the stay-ring connection will be field-welded. This design has been selected on account of the size of the machines and the railroad clearance limitations.

The author's statements regarding the economies to be made by the use of welded construction are presumed to refer particularly to large units for heads up to about 500 ft as listed in Table 1. Such savings cannot be expected in all applications. The all-cast case is still generally preferred for high-head plants, i.e., for heads from 500 to 1500 ft which involve greater metal thicknesses in relation to the over-all dimensions.

Self-Lubricating Bearings. The writer agrees with the author's commendations of the self-lubricating bearing for vertical units but has found that this design is well suited to all sizes of shafts. This conclusion is based on experience with this type of bearing beginning in 1938, and involving 58 units of 2,257,000-hp total rated capacity in operation, and 54 more units of 3,123,000-hp capacity in various stages of construction. For these units the largest bearing in operation is 44-in. diam for a 36-in. shaft, and the largest under construction is 48-in. diam for a 40-in. shaft. Journa surface speeds in operation range from 770 fpm to 3350 fpm.

It has been the writer's practice to provide cooling units in the oil reservoir operating in conjunction with oil circulation caused by the pumping action of the bearing. For surface speeds below 1000 fpm special cooling means may not be necessary.

Carbon Packing Rings. The use of carbon packing rings for the main shaft of hydraulic turbines was reported in a paper by George H. Bragg.[5] This packing was installed when renovating a 40,000-hp 454-ft-head turbine of the Pacific Gas & Electric Company. The writer was informed several years later that this packing was giving excellent service and had not been disturbed since its original installation. It is believed that this turbine was built by the author's company so that possibly he may be able to tell us the life of this packing which was installed 8 or 9 years ago. Perhaps it is still in service.

Carbon packing is considerably more expensive than many other packings so that it should have longer life to justify its use. The use of grease with it is questionable. Some ring manufacturers object to grease on the grounds that it tends to hold abrasive material and to cause more rapid wear of the rings. The grease is unnecessary for lubrication. The writer also has found that carbon rings may wear quickly if exposed to gritty material. The use of a clear-water supply referred to by the author may be necessary for many installations.

Specific Speed—Head Relation. With reference to Fig. 15 of the paper, it is pointed out that the curves of permissible specific speed versus head may be misleading unless correlated to the setting of the unit with respect to tailwater elevation. It is well recognized that the permissible head for a runner of given specific speed is increased by lowering the setting of the unit. It is also true that variations in runner designs in respect to over-all dimensions and blade shapes have an important effect on this problem. Runners of the same specific speed may differ widely in their cavitation characteristics.

In recent years there has been a tendency in Canada to go to higher speeds than normal practice in the United States. This is shown by the list of turbines installed recently in Canada or now under construction for Canadian plants, Table 1.

Eight of these specific speed-head points when plotted in Fig. 15 of the paper, fall slightly below curve 4, and one slightly above. Six of these nine plants are in operation, some of them for many years. From the operating record there seems to be no reason to conclude that the speeds selected were too high.

In regard to European practice, curve 4 does not by any means represent the upper limits of specific speed of units

[3] Head Mechanical Engineer, Tennessee Valley Authority, Knoxville, Tenn. Mem. ASME.

[4] Chief Engineer, Hydraulic Division, Dominion Engineering Works, Ltd., Montreal, Canada. Mem. ASME.

[5] "Maintenance of Hydro-Electric Generating Units," by G. H. Bragg, Trans. ASME, vol. 66, 1944, pp. 329-341.

TABLE 1 TURBINES INSTALLED OR UNDER CONSTRUCTION FOR CANADIAN PLANTS

Plant	Horsepower	Head, ft	Rpm	Ns
Peribonka No. 2	57000	110	105.9	71.0
La Tuque	48000	114	112.5	66.0
Shawinigan No. 3 P.H.	65000	145	120	60.8
Trenche	65000	159	128.6	58.0
Shipshaw	100000	208	128.6	51.2
Waneta	120000	210	120	52.2
Niagara	105000	292	150	40.2
Buntzen	72000	380	240	38.5
Spray	62000	875	450	24.1

actually in service, in some cases for many years. It is probable that more extensive use of stainless steel and greater faith in the value of low settings are contributing factors in addition to the need of conserving materials.

It is of interest to report that the relatively high-head Francis turbine at the Spray Plant of Calgary Power Ltd., is now in service. This unit is rated at 62,000-hp 875-ft head, and is developing about 70,000 hp at full gate. To minimize maintenance expense the runner, wicket gates, distributor plates, seal rings and discharge ring were made of stainless steel, and the unit was equipped with carbon shaft packing and self-lubricating bearing.

AUTHOR'S CLOSURE

Mr. Jessop mentions some interesting additional advantages of fabricated structures, such as the possibility of using even higher design stresses, the lower machining costs, and the elimination of the storage of costly patterns. The satisfactory performance of fabricated structures under severe operating conditions mentioned by Mr. Jessop, confirms the conclusions made by the author, that welding is becoming an important factor in the manufacture of hydraulic turbines.

While it is true that Francis runners using die-formed plate-steel buckets welded to the band and crown have been in service for many years, it is believed that only relatively few runners have been fabricated where actual castings were used for the buckets.

One of the first outstanding runners of this latter type was fabricated in Canada in 1937 for the 29,000-hp 75-ft-head, South Slocan Power Plant for the West Kootenay Power and Light Company. The discharge diameter was 14 ft. The runner buckets were of cast steel welded to a cast-steel crown and a plate-steel band. This runner has been operating satisfactorily for 14 years.

Mr. Petersen states that impregnated metals should be investigated for use as turbine guide bearings. At the present time no such bearings have been developed for use on hydraulic turbines. A bearing of this type was actually tried out on a small hydraulic turbine but proved to be quite unsatisfactory. In this connection, it should be remembered that an extremely long operating life is demanded from hydraulic turbines. For example, an automobile which has been driven 200,000 miles is usually considered ready for the scrap heap. At an average speed of 45 miles per hour this represents about 4500 hours, or one-half year of continuous operation. Compare this to the thirty to forty years of nearly continuous operation of most turbines and it becomes evident that equipment and materials suitable for turbine operation must be given special consideration.

A solution to the turbine guide-bearing problem seems to be the use of self-lubricating bearings. The author stated that the self-lubricating bearings were economical for only the smaller-size shafts. By this was meant that for the smaller shaft diameters, the self-lubricating bearing could be furnished for about the same price as a standard babbitted guide bearing with its complicated oil-pump systems. However, as was so ably pointed out by Mr. Van Patter, self-lubricating bearings can be successfully manufactured for the large-size shafts, and have given satisfactory performance. The question thus becomes one of whether the purchasers of hydraulic turbines with large shaft diameters consider that the advantages of self-lubricating bearings warrant their higher cost.

The initial application of carbon seal rings on new installations of hydraulic turbines was partly influenced by the satisfactory results obtained on the renovation of the 40,000-hp, 454-ft-head turbine of the Pacific Gas and Electric Company mentioned by Mr. Van Patter. The carbon seal rings on this latter turbine have been and are still giving satisfactory service after eight years of operation. However, the original decision to use carbon seal rings was largely based upon the many years of successful operation of lignum-vitae seal rings on hydraulic turbines and the satisfactory performance of carbon seals on centrifugal pumps, steam turbines, and various types of hydraulic machinery.

Mr. Van Patter's Table 1 on specific speeds does not represent a decided departure from the practice of American manufacturers. The curves in Fig. 15 show conservative specific speeds recommended for preliminary investigations. At the time curve No. 3 in Fig. 15 was recommended for such preliminary study, all of the installations shown in Mr. Van Patter's Table 1 were taken into consideration, together with a large number of other installations and operating experiences. Some of the installations by American manufacturers fall about as close to curve No. 4 of Fig. 15 as the ones shown in Mr. Van Patter's Table 1.

It is important that in making a study of a hydro project, other factors such as size of the unit, the setting, the speed-size relationship of the generator, the cost of excavation, the cost of maintenance and repair, the cost of special materials, and so on, all be thoroughly investigated, in addition to the specific speed. The combined effect on the economy of the installation will then determine the best specific speed to use. In some cases this may result in the selection of a high specific speed with a corresponding low turbine setting, while in other cases a lower specific speed may show better over-all economy.

W. J. RHEINGANS.[6]

[6] Manager, Hydraulic Section, Power Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

Aircraft Gas-Turbine Bearing Lubrication

COMMENT BY R. W. BLAIR[7]

The first statement in the paper[8] should be emphasized by adding that the design of aircraft gas turbines is still progressing at such a rapid rate that the bearing manufacturers are not able to keep up to the design requirements. Therefore the engine manufacturers must do their own bearing development. This is not a direct criticism of the bearing industry since the small volume of aircraft business in recent years has not made it economically possible for them to spend the large amounts of money required to conduct extensive development programs. At the present time there is a co-ordinated program under consideration which should alleviate this condition in the future.

The author indicates that his company uses either grade 1005 or grade 1010 oil

[7] Project Engineer, Wright Aeronautical Division, Curtiss-Wright Corporation, Wood Ridge, N. J.

[8] "Lubrication-Bearing Problems in Aircraft Gas Turbines," by E. M. Phillips, MECHANICAL ENGINEERING, vol. 73, December, 1951, pp. 983–988.

for turbojet engines (depending on starting temperatures encountered) and MIL-O-6086 Grade M oil for turboprop engines. Unless unforeseen difficulties arise the Wright Aeronautical Division intends to use a single oil, MIL-L-7808, for both types of turbine engines. This is a new synthetic oil which was developed primarily for high load-carrying capacity in turboprop reduction gears. The table herewith shows the properties of the

PROPERTIES OF LUBRICANTS

Specification	MIL-L-7808	MIL-O-6081 Grade 1010	AF3519 Grade 1005	MIL-O-6086 Grade M
Viscosity, centistokes:				
At 210 F	3 min[a]	2.53	1.63	....
At 100 F	11 min[a]	10 min[a]	5.0 min[a]	60–82[a]
At 0 F	....	220	32	....
At −20 F	....	685	115	....
At −40 F	....	3000 max[a]	400 max[a]	....
At −65 F	13000 max[a]	33000	2600	....
At −67 F	....	40000	....	....
Viscosity index	146	70	83	80
Pour point, deg F	−75 max[a]	−70 max[a]	−75 max[a]	−20 max[a]
Low-temperature stability, deg F	−65[a]	−65 max[a]	−65	....
Flash point, deg F	385 min[a]	265 min[a]	225 min[a]	310 min[a]
Fire point, deg F	....	....	....	....
Pressure-wear index (min)	....	....	....	15
Remarks	....	+ Anti-oxidant	+ Anti-oxidant	Sulphurized load-carrying improver added

[a] Specification requirements.

new oil as well as those in Table 1 of the paper.

It is readily seen that the new oil is far superior to MIL-O-6081 Grade 1010 and MIL-O-6086 Grade M from a cold-starting point of view and is better than Grades 1010 and 1005 as far as viscosity at elevated temperature is concerned. Based on preliminary tests this oil has a gear-tooth load-carrying capacity at least as good as MIL-O-6082 Grade 1100 oil used in reciprocating engines. Another feature of the synthetic oil is its reduced rate of evaporation as compared with grades 1010 and 1005. Fig. 1 of this discussion shows the results of a laboratory test in which beakers containing 0.1 in. of the different oils were heated in a furnace for 1 hr at 300, 400, and 500 F. Admittedly this is not a very exhaustive investigation but it does show the great difference in volatility of petroleum and synthetic oils. It would be interesting to see the results of tests on this oil as outlined in Table 3 of the paper, procedures C and D.

It is quite interesting to see the work of the author's company on larger-size roller bearings because we have just finished a series of tests to obtain operating information on a 140-mm bore, 210-mm-OD bearing. As the author says, consideration must be given to the method of lubrication and the design proportions of the bearing. In our case the oil (grade 1010) was supplied to one side of the bearing and scavenged from the opposite side. Fig. 2, herewith, shows bearing outer-race temperature plotted versus rpm for several different oil flows. Since the oil-out temperature was close to the bearing temperature a good approximation of heat rejection to the oil can be obtained from the curves. The oil-inlet temperature was maintained at 160 F.

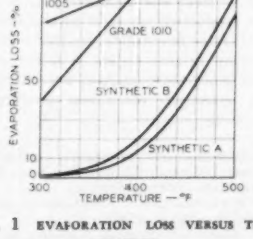


FIG. 1 EVAPORATION LOSS VERSUS TEMPERATURE

(Temperatures held constant for 1 hr with oil samples 0.1 in. deep.)

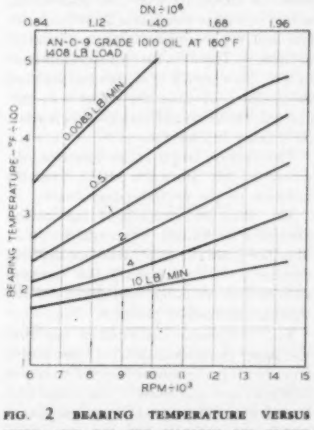


FIG. 2 BEARING TEMPERATURE VERSUS SPEED AND DN FOR VARIOUS OIL FLOWS

(140-mm bore × 210-mm-OD × 28-mm-width 28–17 × 17-mm rollers; Monel-H cage.)

COMMENT BY F. C. JONES[9] AND D. F. WILCOCK[10]

This paper is particularly valuable for its association of the service behavior of bearings with their performance as studied in laboratory test apparatus. One of the most difficult tasks in arranging suitable laboratory tests is to create conditions sufficiently similar to service conditions, so that the results obtained are meaningful. The tests referred to by the author were gratifyingly successful in this aspect while at the same time yielding fundamental information of long-range usefulness. It seems pertinent at this time to add some additional information which has been obtained recently.

In the event of failure of the jet-engine lubrication system for whatever reason, continued operation of the engine for extended periods requires the bearings to run without lubrication and without cooling. Since our experience indicates that roller bearings having silver-plated brass separators can operate for extended periods under these conditions without calamitous difficulties, attention must be focused upon the ball-thrust bearing. In view of the earlier work quoted by the author, it was realized that continued operation of the ball bearing required that at least some minimum quantity of lubricant be retained on the balls and raceways. Experiments were conducted on 110-mm light series ball bearings having synthetic retainers, operating at 7550 rpm.

The results may be summarized briefly as follows:

(*a*) When the supply of grade 1005 lubricant is cut off, continued operation may be expected for short periods of time before seizure of the bearing due to overheating. With 1000 lb thrust load, an operating time of 0.4 hr was obtained. With higher loads the operating time was reduced.

(*b*) Efforts to retain lubricant in the separator by addition of felt pads, or use

[9] Bearings and Chemistry Section, Thomson Laboratory, General Electric Company, Schenectady, N. Y.

[10] Bearings and Chemistry Section, Thomson Laboratory, General Electric Company. Mem. ASME.

of porous bronze were unsuccessful owing to the volatility of the lubricant.

(*c*) The minimum feed required to maintain satisfactory operation with crude seals on either side of the bearing is either 25 cc every 5 min for a discontinuous feed or 0.002 gpm (7 cc per min) for a continuous feed.

(*d*) Use of less volatile oils such as grade 1065 or synthetic diesters increases the operating time before failure after lubricant cutoff.

(*e*) As indicated previously, the initial point of lubrication failure is at the sliding surfaces between ball and raceway and, therefore, these are the critical points requiring constant lubrication in ball bearings.

COMMENT BY GEORGE P. TOWNSEND, JR.[11]

This paper has touched on a subject in bearing design for aircraft gas-turbine engines which needs much additional study. The development of a design which will operate without failure for extended time after an oil-system failure is now being followed actively by most engine manufacturers.

This paper reports a part of the investigation which is pointed to improvement of the most vulnerable part of the bearing in an oil interruption, namely, the roller cage. By plating the cage with various materials, attempts are made to reduce metal transfer or welding of the cage rubbing surfaces to the steel parts. An additional attempt to prevent failure by providing a stronger basic cage material is discussed.

The type of investigation presented here is necessary in the development of bearings which will withstand oil-system failure, and the results shown are valuable. However, the limited amount of data presented in the paper does not justify completely the conclusions drawn.

In particular, we must examine the average results shown in Table 3 of the paper under procedure D. It is believed by the writer that three tests of each type are not adequate to evaluate properly the advantage of silver-plated cages over the unplated brass cages. For instance, tests by the writer's company, where larger quantities of each type were run, have demonstrated some early failures of the silver-plated type as well as long runs on the standard unplated brass type. As a result of these tests a simple average would show no particular advantage of silver-plated bearing cages over the unplated configuration. Examination, however, of the data from tests in which bearings failed early would show that the silver-plated configuration is slightly better; i.e., the minimum time to failure for the unplated cages is less.

This paper also touches on developments which are being studied involving improvements to the basic cage material. Monel "H" is one of several stronger materials, one which will stay together even with fairly high drag forces. This has been shown to be an improvement, but the statement that Monel cages provide a life of 3 to 4 times the life of silver-plated yellow-brass retainers implies that the Monel retainer bearings will run for an average of 15 to 20 hours after failure of oil supply.

Similar tests at the reviewers' company do not substantiate this. These tests show that bearings made with these cages are more consistent in their operation time without oil to failure, but the average life to failure shows only a small improvement over a standard unplated-cage material.

AUTHOR'S CLOSURE

The author wishes to thank Messrs. R. W. Blair, F. C. Jones, D. F. Wilcock, and G. P. Townsend, Jr., for their valuable comments on, and additions to, the data presented in his paper.

As pointed out in the paper, the J47 engine, built by the author's company, after many hours of successful test cell and flight operation using 1005 oil, was approved for operation at all temperatures with this oil. During the last two years much effort has been devoted to the development of synthetic lubricants which would not be as subject to evaporation as either 1005 or 1010 and which would lubricate satisfactorily at both the low and high temperatures encountered in flight. The data on this development by Mr. Blair, much of which has reached successful trial since the paper was first drafted, are a real addition to information on bearing lubrication.

The data on larger roller bearings presented by Mr. Blair are also a valuable addition to the available test results.

The data on interrupted lubrication presented by Messrs. Jones and Wilcock, obtained since the paper was first drafted, explore a field previously not reported and furnish valuable new light on the bearing-lubrication problem.

Mr. Townsend has pointed out that the paper presents insufficient test points to accurately determine relative values of bearing-cage materials. The data presented were determined for the purpose of obtaining an improvement in cage material rather than in establishing definite life comparison. The practical advantage of the changed material was determined by the freedom from difficulties obtained in unit testing and in service. Because of the successful elimination of troubles, no further laboratory tests were required. Naturally, if these results are to be applied to other designs, it is likely that more testing will be needed and also that other material or design changes will be required. Any added data presented should be an aid under such conditions. The author believes that any design must be finally determined by service testing of units and that laboratory testing, at best, can only furnish guides. Actual comparisons, in the two cases, may not agree numerically.

E. M. PHILLIPS.[12]

Moral Concepts in War Production

COMMENT BY T. RANDALL DU BOIS[13]

The paper,[14] as presented, deals rather specifically with war production. Production managers are all aware of the moral obligation of producing as quickly as possible that which is necessary to make this country stronger than any potential enemy. We must be aware, however, that danger does exist—that our military might could make us too aggressive. This would lead us into the very war which we are trying to prevent in our efforts to defend ourselves.

Our objective, as I see it, should be to come to a peaceful agreement with our potential enemies, and then to direct our productive efforts to make the entire world a better place to live in. Especially, we should avoid the tendency which now exists to stress the need for more and more guns and airplanes in order to keep our industrial system working at top capacity. We should emphasize to our employees, and to our government that the first objective is peace. Recognizing this, production managers then will have a moral and spiritual obligation to turn as quickly as possible from war production to peacetime production, as soon as the urgent needs of our government are met. Good planning in this respect will not only bring peace more quickly, but will prevent depression when war production tapers off.

[11] Aviation Gas Turbine Division Engineering, Westinghouse Electric Corporation, Lester, Pa.

[12] Staff Engineer, Aircraft Gas Turbine Department, General Electric Company, West Lynn, Mass. Mem. ASME.

[13] Works Manager, Ramsey Corporation, St. Louis, Mo. Mem. ASME.

[14] "Moral and Spiritual Concepts in War Production," by E. H. Schell, MECHANICAL ENGINEERING, vol. 74, February, 1952, pp. 128–130.

Auxiliary Gas-Turbine Engine

COMMENT BY R. TOM SAWYER[15]

The authors are to be commended for an excellent paper.[16] The writer wishes to point out that the company involved is gaining a great deal of know-how and experience over a wide field. The knowledge gained from this turbine unit, combined with its small 50-hp unit, makes it possible to have actual test data and design information on both the axial and the centrifugal compressors and also on both the axial and radial-inflow turbines. It is possible that a new turbine unit may be developed in time by this organization that will be a different combination of component units and give even better results than the present two units, or even those as proposed, including the split turbine.

COMMENT BY H. J. WOOD[17] AND W. T. VON DER NUELL[18]

We find ourselves in substantial agreement with most of the material presented, and wish to add our concurrence with particular reference to the advantages of a single combustion chamber on a small machine. It is felt that the whole gas-turbine industry has been too much influenced by aviation gas-turbine developments, which necessarily place great emphasis on reduction of frontal area. The use of a multiplicity of combustors has resulted. In general, no such limitation applies to stationary gas turbines or those for auxiliary services, and it would appear that considerations of serviceability and long life very strongly favor minimization of numbers of combustors and spray nozzles. It would be appreciated if the authors would present some additional information on their experience with the variable-area fuel nozzle and the particular pressure versus flow characteristics found satisfactory.

Although the specific application involved here does not place great emphasis on minimization of fuel consumption, it is believed that the design is somewhat wasteful in that the heat dissipated to the cooling air, which shrouds the turbine section, is not recovered. In some recent designs of single combustion-chamber engines with which we have been associated, this necessary cooling of the hot turbine surfaces is accomplished by shrouding the whole region with compressed air which later passes through the combustor.

The authors' statements with respect to the merits of axial-flow compression are subject to some challenge. We believe that a two-stage centrifugal compressor can be built for this size class which would have the same performance as the axial-flow machine described. Even if it were slightly deficient in efficiency, the reduced production cost of the centrifugal machine would make it worthy of serious consideration. As noted previously, the requirements of small frontal area, which have favored the axial-flow machines for aircraft-propulsion purposes, do not apply here. It is noteworthy that the company involved is currently using radial-flow compression in a smaller gas turbine. Probably we shall someday see a line of delineation between axial-flow and radial-flow machines based upon horsepower ranges.

COMMENT BY D. R. ZENO[19]

The gas-turbine engine seems to be ideally suited for isolated locations in regard to repair of the engine and the use of cooling water when it is at a premium. However, further study would appear to be in order where direct competition with the Diesel engine is contemplated, especially aboard ship.

It would be of considerable interest to see a specific comparison of the gas-turbine engine with the Diesel engine, including total weight of critical materials employed and weight in pounds per horsepower, noise level, and expected life of renewal parts. The comparison should be with reference to lightweight high-speed Diesel engines of equivalent life rating and including silencers currently in use.

AUTHORS' CLOSURE

In regard to Mr. Sawyer's comments, consideration of cost, compactness, or over-all weight may well lead to combining of axial-flow and radial-flow configurations in both compressors and turbines. For example, the addition of a mechanically divorced axial-flow turbine wheel would undoubtedly provide the lightest and most compact conversion of the Solar T-45 50-hp fire-pump-drive gas turbine, now single shaft with radial-flow compressor and turbine, for applications requiring a variable speed drive.

Replying to the comments of Messrs. Wood and von der Nuell, the variable-area fuel nozzle was used primarily to insure ignition of the fuel under adverse conditions, rather than as a means of improving combustor efficiency at light loads. The nozzle used provides reduced area up to an equivalent of 11 per cent of rated fuel flow, at which point the differential nozzle pressure is some 75 psi and the spray angle 92 deg.

The use of compressor-discharge air to cool the turbine casing and subsequently passing this air through the combustor, would result in improved economy, providing the pressure losses involved by so doing were not too great. The mechanical complications and possible weight increase arising from the necessity of providing airtight, high-pressure shrouding did not, however, appear warranted in the application involved.

The controversy between the centrifugal compressor, single or two-stage, and the axial-flow compressor resembles in some respects the controversy of a few years back between the air-cooled and liquid-cooled aircraft engines. Since the cost, weight, and susceptibility to damage and fouling of the centrifugal compressor are, in varying degree, less than for the axial, the peak efficiency is also less except in the small sizes (below 2 to 4 pps air flow), selection of the gas-turbine compressor involves primarily a consideration of the use factor, i.e., percentage of time operated and the cleanliness of the inducted air. Secondary considerations include length-to-diameter ratio desired for the engine (secondary in nonaircraft application), percentage of time operated at part load, and the length of time available for development, the centrifugal compressor having a broader range for efficient operation, but in the writers' experience, likely to require more test-stand development to obtain desired performance than is the case with axial. Ideally, the type of compressor to be furnished with a gas turbine should be at the option of the customer, selected to suit the application involved.

Considering Mr. Zeno's comments, suggesting a comparison between Diesel engine and gas turbine on the basis of weight of critical materials, weight per horsepower, noise level, and expected life of renewal parts, the authors are well aware that the gas turbine is currently competitive with the Diesel engine in a relatively small number of specialized Navy applications. It must

[15] Manager, Research Department, American Locomotive Company, New York, N. Y. Mem. ASME.

[16] "Design Features of a 250-Kw Gas-Turbine Engine," by R. R. Peterson and P. G. Carlson, MECHANICAL ENGINEERING, vol. 74, March, 1952, pp. 197–201.

[17] Assistant Chief Engineer, Turbomachinery, AiResearch Manufacturing Company, Los Angeles, Calif. Mem. ASME.

[18] Project Engineer, Gas Turbines, AiResearch Manufacturing Company.

[19] Newport News Shipbuilding and Dry Dock Company, Newport News, Va. Mem. ASME.

be admitted that the 250-kw gas turbine described was quite lavish in its use of critical materials, and though much can be done to reduce the amount of critical material, it is doubtful if the percentage can ever be reduced to that of the Diesel engine. However, when one considers that the weight per horsepower of a simple gas turbine is only 10 to 20 per cent that of the Diesel, it is evident at least that a substantial amount of steel and cast iron is conserved by the use of this form of prime mover. Enough evidence is now available to prove that the noise level of the gas turbine can be reduced to that of an equivalent size Diesel engine, with no penalty in performance. In regard to expected life of renewal parts, the investigation of this factor, together with the associated problems of availability, time required for parts replacement, and the cost of parts replaced, is the objective of a number of factory and field gas-turbine test programs being conducted both in this country and abroad; sufficient information for comparisons with other prime movers should be available in the not too distant future.

R. R. PETERSON.[20]
P. G. CARLSON.[21]

[20] Head, Gas Turbine Section, Bureau of Ships, Department of the Navy, Washington, D. C. Mem. ASME.

[21] Project Engineer, Solar Aircraft Company, San Diego, Calif. Mem. ASME.

Thermodynamics or Energodynamics

TO THE EDITOR:

The science of thermodynamics grew out of the caloric theory of heat in the 19th century and at that time the name of the new science was fully justified as it treated chiefly of heat and its transformation into mechanical energy or vice versa. The recognition of other forms of energy, such as electrical, magnetic, radiant, chemical, surface and atomic, and fitting these into the laws of thermodynamics completely changed the picture of the science so that in a recent definition of thermodynamics the word "heat" is excluded entirely. Let us, for instance, cite the definition of thermodynamics given by F. D. Rossini:[22] "Thermodynamics provides laws that govern the passage of energy from one system to another, the transformation of energy from one form to another and the utilization of energy for useful work." The same or similar definitions can be found in any modern book of thermodynamics.

Moreover, in order to preserve the validity of the First Law of Thermodynamics in the light of Einstein's theory of relativity, confirmed by recent experiments on atomic energy, we have to drop the principle that energy cannot be created or destroyed, and we have to assume that energy and matter are two equivalent forms of energy (or matter). This fact moves the science of thermodynamics still further from heat.

Bearing in mind, therefore, that the thermodynamics of present days deals with various kinds of energy and that the thermodynamics of the future will introduce matter as a new form of energy, the adoption of a new name for a completely changed science seems to be desirable. In my opinion the word "*energodynamics*" best meets the requirements of the modern definition of the science.

From the formal point of view such a change is not difficult or impossible as in our times much more important names, those of states (Iran for Persia), and of capitals (Oslo for Christiana) have been changed.

LEON S. KOWALCZYK.[23]

[22] "Chemical Thermodynamics," by Frederick D. Rossini, John Wiley and Sons, Inc., New York, 1950, p. 1.

[23] University of Detroit, Detroit, Mich.

Properties of Cast Iron

COMMENT BY C. O. BURGESS[24]

This paper[25] is of great interest to us working in the gray-iron field, pinpointing as it does those gray-iron properties on which designers need more accurate and specific information. The author bases his discussion on the excellent bulletin on engineering properties of cast iron published by the American Foundrymen's Society. Despite the value of this bulletin—and it is valuable both as an effective introduction and as giving a broad background picture of the physical properties of the family of metals known as cast or gray irons—it must, like any technical work, be considered as only one of a series of treatises that will consider particular properties in greater detail. For example, important later investigations on specific gray-iron properties, necessarily omitted in the quoted bulletin, include numerous additional references.[26]

These investigations correct some common misconceptions as to gray-iron properties and reveal (*a*) that gray iron can be stressed safely up to 25 per cent of its ultimate strength with only negligible plastic deformation on initial loading, (*b*) gray-iron beams obey Hooke's law in bending up to 30 per cent of their ultimate load, and (*c*) a method is available by which the strength of a cast-iron beam of any section shape can be predicted accurately. It may be of interest that we in the Gray Iron Founders' Society are correlating and accumulating data in the mechanical property field, and eventually will publish a manual on special design properties of gray iron to supplement the earlier work noted.[26]

The paper serves to emphasize the important fact that all workers in the metallurgical field, and especially in the gray-iron field, need continuous contact with men in the designing field. Both groups are badly handicapped without it. Technical meetings partially answer this need, and it is hoped that representation on ASME Division Committees of technical personnel from producer societies will be of further help.

[24] Technical Director, Gray Iron Founders' Society, Inc., Cleveland, Ohio.

[25] "Physical and Mechanical Properties of Cast Iron," by W. L. Collins, MECHANICAL ENGINEERING, December, 1951, pp. 979-982.

AUTHOR'S CLOSURE

The comments made by Dr. Burgess relative to the additional publications contributing materially to our knowledge of mechanical properties of gray cast iron are indeed pertinent. The author intentionally limited the scope of his paper to the contents of the one publication, "Engineering Properties of Cast Iron," and did not intend to imply there were no other valuable sources of information of more recent date. He is grateful to Dr. Burgess for the listing of the references. The author also agrees with Dr. Burgess when he says, in essence, that a closer association between the workers in the field of metallurgy of gray cast iron and those in design is highly desirable.

W. LEIGHTON COLLINS.[27]

[26] "Symposium on Testing Cast Iron with SR-4 Type of Gage," ASTM Special Publication No. 97, 1949.

"Stress-Strain Tests on Rectangular Cast Iron Beams," by O. Smalley, ASTM Special Publication No. 97, 1949; and *Iron Age*, vol. 166, November 10, 1949, pp. 83-86.

"Strain Testing of Meehanite Castings," ASTM Special Publication No. 97, 1949, and separately published by the Cooper-Bessemer Corporation.

"Transverse Properties of Bars of Various Cross Section," by G. N. J. Gilbert, British Cast Iron Research Association, *Journal of Research and Development*, April, 1951.

[27] Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.

Swiss Register of Engineers

TO THE EDITOR:

We have noted with utmost interest the article "Engineering Achievements in Switzerland and Their Background," by Frederick Oederlin, managing director, charge of engineering, Sulzer Brothers, Ltd., Winterthur, Switzerland, published in MECHANICAL ENGINEERING, November, 1951.

We were particularly interested in the section about the professional education of Swiss engineers (page 879). The engineers and architects in Switzerland have formed four professional organizations, i.e., the Swiss Society of Engineers and Architects, composed of members with academic training, the Union Technique Suisse incorporating engineers and architects with nonacademic training, the Association of Swiss Architects which is mostly interested in artistic questions, and the Association Suisse des Ingénieurs Conseils. The Union Technique Suisse, numbering about 8000 members trained at Swiss technical schools, called "Technicums," is very much gratified to note what Mr. Oederlin, one of the outstanding exponents of our industry, says about our professional education and qualification. Such testimony is of the utmost value for us.

We would, however, like to draw your attention to the fact that the author of the article does not mention the recently signed agreement[28] for the protection of professional titles in Switzerland. Perhaps his manuscript was written before the signing of the agreement. It might interest you to know that after long negotiations, discussions, and fights, the above-mentioned associations have come to an agreement concerning a Swiss Register of Engineers, Architects, and Technicians.

The agreement provides that former students of the Swiss Federal Institute of Technology, Zurich, and the Ecole d'Ingénieurs, Lausanne, will be entered without any formality in the Register of Engineers and Architects. Former students of the nonacademic schools, such as the so-called "Technicums," can be registered according to stipulated conditions, if they can prove that they have had 7 years of practice as an engineer, after termination of their studies at school. It is equally possible for persons who have not been at any technical school (self-made men) to be entered in the Register of Engineers after 15 years of practice as an engineer.

By the signing of the agreement, the Swiss associations of engineers have recognized the principle that it is possible for persons without academic training to be entered in the Register of Engineers. This is a point of the utmost importance for the former students of nonacademic technical schools. For the engineers with academic training, it means recognition of the high quality of the professional education of the Swiss Technicums as well as of the contribution of the technicians in the success and achievements of Swiss industry.

H. A. GONTHIER.[29]

[28] Copies of this agreement, in German and in French, accompanied this letter.
—EDITOR.

[29] The Secretary, Union Technique Suisse, Zurich, Switzerland.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Systems Analysis for Effective Administration

SYSTEMS ANALYSIS FOR EFFECTIVE ADMINISTRATION. By Norman N. Barish. Funk & Wagnalls Company, New York, N. Y., 1951, in association with Modern Industry Magazine, New York. Cloth, 5¾ × 9 in., 101 figs., tables, index, x and 316 pp., $5.

REVIEWED BY ELLES M. DERBY[1]

THIS book seeks "to discuss the means of finding the most effective, simplest, and cheapest means of accomplishing every task." Professor Barish specifically points his book at "supervisors, staff personnel . . . . . office planners, college students, and top management personnel." In trying to point the discussion in so many directions we are inclined to feel that the author set for himself an impossible task. The book is effective in certain areas for certain of the named groups, but is far too sketchy in spots to satisfy all. It is a valuable addition to the slowly expanding library of texts on the subject of systems work, particularly for those who are not skilled in this field. Especially to be commended and recommended to others is the author's ability to express himself in technical areas without restoring to that peculiar brand of "gobbledegook," all-too-frequently found in semitechnical literature.

The author first presents an excellent picture of systems work: its scope, its accomplishments, and its importance to modern business. His principles of good systems, while overlapping, probably unavoidably, are excellent and expressed in a way certain to be clear to top-management levels of organization. Those who are concerned with the favorable presentation of systems work to top executives will find much ammunition in this section of the book. It is a rather complete orientation in the "why?" of systems work.

In the following 200 pages we find a description of virtually every tool of systems work. We feel there is an undertone of blithe optimism in the suggested use of many of them. On the other hand, the objective of each tool is clearly expressed and the author could hardly be expected to do all the reader's thinking for him.

In this section of the text the author covers the planning of a systems study and fact-gathering techniques in a way, we feel, much too optimistic for practice.

His following chapters on the analysis of the allocation of functions, of work flow, of office layout, of work-place arrangement, of forms, and of machine utilization present brief glimpses into what are frequently complex problems.

The chapter on machine utilization is the weakest in the book and might well have been omitted for all the practical benefit it is. The author has fallen into the pit of academic theory in attempting to sell the multiple-activity process

[1] Manager, Management Education, Coordination Division, Metropolitan Life Insurance Company, New York, N. Y. Mem. ASME.

chart and the Dvorak-Dealy simplified typewriter keyboard to his readers.

Professor Barish figuratively leaps from peak to peak in the next section titled, "Evaluation, Selling, and Installation of Procedures." He devotes several pages to some of the accounting errors thought by him to hurt future sales of systems work, using as illustrations industrial rather than office equipment.

The chapter on reports is excellent from all points of view and is, in addition, a concise, clear example of how to write well.

In bringing the book to a close, the author attempts to put into a few pages what might well be a text in itself on organization of the systems department, personnel adjustments resulting from systems studies, supervisory training, control of the systems function, follow-up, organization manuals, charts, project controls, and control of procedures, forms, layouts, and equipment. The final words concern the qualifications for successful systems men, one of which is "the systems man must always be a skeptic."

Readers may well heed that advice when accepting some of the author's ideas at face value. If that advice is heeded, the reader will find this an all-inclusive and excellent glossary of systems terms and tools.

Data Book for Civil Engineers

DATA BOOK FOR CIVIL ENGINEERS, in three volumes Design, vol. 1; Specifications and Cost, vol. 2; Field Practice, vol. 3 (stet as of 1947). By E. E. Seelye. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, vols. 1 and 2. Second edition, 1951. Design: Cloth, 9 × 11½ in., illus., index, xxxiii and 662 pp. (each chapter separately numbered), $10. Specifications and Costs: Cloth, 9 × 11½ in., charts, tables, graphs, glossary (pp. 401–497), index, xii and 506 pp., $13.

REVIEWED BY G. R. RICH[1]

IN THE second edition of this very useful and comprehensive data book the following major additions have been incorporated:

1 "A wider range of 'push button' design data, such as an expansion of spread footing tables.

2 "Simple, nontechnical explanation of soil behavior and the application of the principles of mechanics to soils designed to enable the engineer to utilize soil mechanics without being a specialist in the field.

3 "Up-to-date airfield design data, including the latest airport layouts.

4 "Standards for swimming pools.

5 "Rigid frames have been extended to help the engineer obtain his solutions as simply as possible by: (*a*) push-button solutions of a large number of frames; (*b*) numerical examples of common rigid-frame problems, including variable sections; (*c*) solution of rigid-frame bridge bents by influence line data; (*d*) design data of a large number of existing rigid-frame bridges.

6 "Data on industrial waste treatment in the Sanitary Section.

7 "Under Dams will be found details of equipment such as gates, flash boards, fish ladders.

8 "To Highways have been added further data such as sight distances, maximum curvature, and grades. Also the New York Thruway and New Jersey Turnpike standards for intersections have been added.

9 "An interesting addition to hydrology is a problem in computing runoff by the unit hydrograph method."

In the foregoing additions the author again demonstrates his faculty for extracting the kernel of a technical subject and presenting the essentials in the form most readily assimilable by the designing engineer. The presentation of the unit hydrograph and the working elements of soil mechanics are definitely in this category. The tabulation of airfield pavement data is particularly useful not only for direct design but also for checking the dowel size and spacing that are obtained by the application of any of the special theories prescribed by certain individual clients. The section on industrial waste treatment is timely and certain to become of increasing usefulness with more rigid enforcement of pollution-abatement legislation.

The second edition of volume two includes the following new material:

"Specifications for the elements of an industrial building; an example of an evaluation report; swimming-pool specifications; information on charging off obsolescence; seeding and sodding; costs of miscellaneous structures, including ski tows, deep sewers, tunnels, drive-in theaters; *Engineering News-Record* Construction and Building Cost Indices; also Dun & Bradstreet's indexes relating to cost of construction; costs for the elements of buildings; square foot costs of industrial buildings; relative costs of Diesel, steam, and hydroelectric power; as well as the elements which enter into these costs."

The new section on appraisals, depreciation, and obsolescence presents in condensed readily assimilable form, an important segment of the practice of the consulting engineer. Relative costs of Diesel, steam, and hydroelectric power are also of the greatest current usefulness, while the section on construction cost indexes is an essential feature to which constant recourse is necessary in the preparation of estimates.

The revised editions of the "Data Books" continue to constitute the most comprehensive single collection of essential working data in engineering literature and the new material incorporated is both timely and pertinent.

[1] Member of the firm, Charles T. Main, Inc., Boston, Mass. Mem. ASME.

Plastics Molding

PLASTICS MOLDING. By John Delmonte. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, 1952. Cloth, 5⅞ × 9 in., figs, tables, bibliography, vii and 493 pp., $9.

REVIEWED BY G. B. THAYER[1]

THIS book deals primarily with the fixed equipment which is used in the plastics-molding plant. A brief introductory chapter concerning the nature of the plastics materials which are encountered in the molding plant is included . . . "because an understanding of their behavior under heat and pressure is essential to the proper handling of their processing equipment."

Chapters 2, 3, 4, and 5 consider the equipment for supplying the power used in operating molding presses. Hydraulic pumps, mechanical pressure systems, accumulators, packing, and valves are discussed in detail from the simplest to the most advanced types in use. This provides a test on practical hydraulic equipment for the plastics engineer which is an excellent supplement to his general college studies.

Chapter 6 is concerned with distribution of the gases and fluids, steam, air, oil, water, and heating gas used in the molding plant. Chapter 7 is an extensive discussion of the various heat sources for plastics molding.

Material preparatory equipment such as preforming machines for phenolic molding powders, fibrous plastics, and resin-board compounds is discussed, as well as preheating equipment including dielectric heating units in chapter 8. Color blending and scrap-grinding equipment are also discussed for thermoplastic materials.

[1] Plastics Technical Service, The Dow Chemical Company, Midland, Mich.

Automatic and semiautomatic equipment in a wide range of sizes and types for compression and transfer molding is discussed in chapter 9. Explanations are detailed, concise, brief, and well illustrated. The design of compression and transfer molds is given extensive treatment in the chapter which follows.

Injection-molding machines and molds are treated briefly in the next two chapters which serve as an excellent guide to the various types of machines and molds which are used in the industry. Considerable detail is presented and the reader is referred to several more specialized publications in this field.

Chapter 13 discusses equipment for extruding thermoplastics and thermosetting materials as well as blow-molding and color-compounding equipment for thermoplastics.

Finishing molded plastic articles often involves more manufacturing than the molding operation. Chapter 14 discusses some finishing equipment well, but the subject is probably large enough for an entire book.

Temperature-control instruments and timers are well discussed in the next chapter, and some helpful suggestions are given the engineer concerning plant layouts in the final chapter. The book is well indexed, both by subjects and proper names.

The author has succeeded in keeping his book limited to everyday practical considerations. He has not included irrelevant information to any great extent. The book should be valuable to the mechanical engineers charged with production or maintenance of the molding plant. It is written so the superintendent or foreman without formal engineering education can use it for reference purposes.

A few points of disagreement were found by this reviewer in the section on injection molding. These points are mainly controversial at present. This criticism is mostly a wish that their controversial nature could have been stated so as to warn the reader to think his own thoughts and thereby avoid to some extent the possibility of being misled.

Books Received in Library

ACTES DU COLLOQUE INTERNATIONAL DE MÉCANIQUE. Poitiers, 1950, vol. 3: Étude Sur La Mécanique Des Fluides. France, Ministrère de l'Air, Publications Scientifiques et Techniques. No. 251, 1951. Paper, 7 × 10½ in., 335 pp., illus., charts, diagrams, tables, 1800 fr. This third volume of an international conference on mechanics contains twenty-six papers completing the section dealing with fluid mechanics. They are broadly classified in three main categories: problems in connection with the action of the wind—meteorological, aeronautical, and so on; experimental methods of analyzing the mechanics of fluid motion; and discussions of various aspects of the phenomena of turbulence.

ADHESION AND ADHESIVES. Edited by N. A. DeBruyne and R. Houwink. Elsevier Publishing Company, Houston, Texas, 1951. Cloth, 6½ × 9¼ in., 517 pp., illus., diagrams, tables, charts, $10. A symposium on the theoretical and technological aspects of adhesion, this volume applies physico-chemical theories to the solution of adhesion problems of diverse materials and trades. Part 1 deals with the theoretical aspects of adhesion and the mechanical properties, forces, and conditions required to produce this state. A chapter on static problems is included. Part 2 discusses technological aspects including the various types of adhesion and adhesives and their physical testing.

AERODYNAMICS OF THE HELICOPTER. By Alfred Gessow and Garry C. Myers, Jr. The Macmillan Company, New York, N. Y., 1952. Bound, 5¾ × 8½ in., 243 pp., diagrams, charts, tables, illus., $6. A complete, practical guide to the basic factors affecting the aerodynamic behavior of rotating-wing aircraft. The mechanisms and general flight and operating characteristics are first described. The aerodynamic theory of the rotor is then developed and applied to the prediction of helicopter behavior for all steady flight conditions—power-on and autorotation. A bibliography of NACA papers on rotating-wing aircraft is included as well as representative reference material from other sources.

AUFBAULEHRE DER VERARBEITUNGSMASCHINEN. By K. Rauh. Two volumes Verlag W. Girardet, Essen, Germany, first edition, 1951. Bound, 6 × 8¼ in. 278, 159 pp., diagrams, charts, $10 (set). A treatise covering a systematic study of the synthesis of production machinery with emphasis on design. Machine types are classified, handling problems are considered, and the differentiation between manual processes and processes suitable to machinery is discussed. Design practice is based on type of work to be done and the motion of the workpiece. Among the problems dealt with is the combination of work groups into production units. The kinematic approach is exemplified in the illustrations, presented in a separate volume.

BERECHNUNG UND GESTALTUNG VON METALLFEDERN. (Konstruktionsbücher, no. 3) By Siegfried Gross. Springer-Verlag, Berlin, Germany, second edition, 1951. Paper, 6 × 9 in., 95 pp., diagrams, charts, tables, 7.50 Dm. A concise mathematical treatment of the calculation and design of a number of spring types: leaf springs, disk springs, cylindrical, and conical coil springs. A few special types are briefly considered.

BERECHNUNG UND GESTALTUNG VON WELLEN. (Konstruktionsbücher, no. 10.) By F. Schmidt. Springer-Verlag, Berlin, Germany. Paper, 6 × 9 in., 79 pp., diagrams, tables, charts, 9.60 Dm. This small book on shafts gives a concise presentation of the methods of determining forces and moments acting on shafts, of calculating vibration conditions, and of establishing practical design considerations.

CONFORMAL MAPPING. (International Series in Pure and Applied Mathematics.) By Zeev Nehari. McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1952. Bound, 6½ × 9¼ in., 396 pp., diagrams, $7.50. The potential theory and complex function theory necessary for a full treatment of conformal mapping are developed in the first four chapters, making the reader independent of other texts on complex variables. This section, suitable for a first course in the subject, is followed by a graduate-level treatment of the various techniques available for the conformal mapping of given geometric figures as well as discussion of the mapping properties of special functions. A working knowledge of advanced calculus is a prerequisite.

CONTRIBUTION A L'ÉTUDE DES COUCHES LIMITES TURBULENTES AVEC GRADIENT DE PRESSION. By Roger Michel. France, Ministere de l'Air, Publications Scientifiques et Techniques. No. 252, 1951. Paper, 7 × 10½ in., 128, 23 pp., charts, tables, 900 fr. The major part of this pamphlet is devoted to explanation and discussion of methods of analysis of turbulent boundary layers with pressure gradients, for a flat plate and for two airfoil sections. These analyses are related to experimental determinations. This is preceded by discussion of boundary layers for a flat plate without gradients.

ELEMENTS OF HARDENABILITY. By M. A. Grossmann. American Society for Metals, Cleveland, Ohio, 1952. Bound, 6½ × 9¼ in., 164 pp., charts, illus., diagrams, $4.50. Four main fields of interest are discussed: methods or tests for determining hardenability; the nature of hardening, particularly with regard to isothermal transformation; quenching and its quantitative relationship to depth of hardening; the influence of alloying elements on hardenability. A six-page bibliography lists the articles to which reference is made in the text.

FLUID FLOW IN PIPES. By Clifford H. McClain. The Industrial Press, New York, N. Y., 1952. Bound, 6 × 9¼ in., 123 pp., tables, charts, diagrams, $3. A summary of modern theory in the flow of liquids and gases through piping and ducts. The book deals in a concise simple manner with viscosity, friction, turbulence, steam-line flow, head, and other factors which influence the overall result. Dimensional relationships are emphasized. Practical applications and detailed worked-out examples help to clarify the handling of piping problems.

FOUNDATIONS OF HIGH SPEED AERODYNAMICS. With a bibliography compiled by George F. Carrier. Dover Publications, Inc., New York, N. Y., 1951. Paper, 6¼ × 9¼ in., 286 pp., charts, illus., tables, $1.75. A compilation of facsimiles of nineteen fundamental studies as they were originally reported by the investigators, arranged chronologically from Rankine in 1870 to Tomotika and Tamada in 1950. It is not actually a book on aerodynamics but rather a coverage of the various subdivisions of compressible fluid theory. An extensive bibliography is classified under the following: hodograph method; Rayleigh-Janzen method; Prandtl-Glauert method; supersonic flow; shock waves; boundary layer; the oscillating airfoil and other unsteady flow phenomena; general.

HYDRAULISCHE UND MECHANISCHE TRIEBE FÜR GERADWEGE AN WERKZEUGMASCHINEN.

(Werkstattbücher, No. 101.) By Hans Rögnitz. Springer-Verlag, Berlin, Germany. Paper, 6 × 9 in., 65 pp., diagrams, charts, tables, 3.60 Dm. Brief, detailed descriptions of hydraulic and mechanical devices for producing linear travel of machine tools. The main treatment is of fluid drives and crank gear, with some attention to screw mechanisms—worms, rack and pinion, and so on.

INTRODUCTION TO THE ENGINEERING PROFESSION. By John G. McGuire and Howard W. Barlow. Addison-Wesley Press, Inc., Cambridge, Mass., second edition, 1951. Bound, 6¼ × 9¼ in., 260 pp., illus., tables, diagrams, $5. An occupational study of the principal fields of the engineering profession, discussing the nature of engineering, aptitudes, requirements, preparatory courses, kinds of work involved, and prospects in the field. A section is devoted to illustrative problems in the various branches, primarily for use in a course on engineering problems, but also intended to show what the engineer must solve and how he goes about it.

MANUFACTURE OF IRON AND STEEL. By G. Reginald Bashforth. Volume 2: Steel Production. Chapman & Hall, Ltd., London, England, 1951. Bound, 5⅜ × 8⅜ in., 461 pp., illus., tables, diagrams, charts, 45 s. Together with volume 1 (1948), on iron production, this two-volume set forms a complete treatise on the subject. The present volume deals comprehensively yet simply with the acid and basic Bessemer processes, the acid and basic open-hearth processes, electric furnaces, ingot production, side-blown converter practice, special steels, steel-works instruments, and refractory materials. The book is intended as a reference work for industrialists as well as a textbook.

METHODES NOUVELLES POUR LE CALCUL DES CHAMBRES D'ÉQUILIBRE. By L. Escande. Dunod, Paris, France, 1950. Cloth, 7½ × 11 in., 357 pp., tables, diagrams, 1850 fr. Detailed tables, graphs, and instructions are given for the analysis and calculation of surge-chamber phenomena by two methods a method of finite differences and a semigraphic method. Several types of chambers are dealt with under a variety of conditions. Experimental verification of several applications of these methods are given. All analyses and calculations are carried out with full mathematical manipulation. A critical comparison of the two methods is included.

PAPER AND PAPERBOARD. Characteristics, Nomenclature, and Significance of Tests. Sponsored by ASTM Committee D-6 on Paper and Paper Products. (Special technical publication No. 60-A). American Society for Testing Materials, Philadelphia, Pa., October, 1951. Paper, 6 × 9 in., 126 pp., tables, $2.50. The introduction outlines the structure of paper, the essential steps in paper manufacture, and the properties of paper. Part 2 covers the action of water on paper; Part 3 defines and characterizes the various classes of paper and paperboard; and Part 4 discusses in detail the types of tests to which paper is subjected and the extent to which these tests are indicative of quality and usefulness for specific purposes. A full list of ASTM and TAPPI test methods is included.

PAPERS ON EVALUATION OF SOAPS AND DETERGENTS. (ASTM Special Technical Publication, No. 115.) American Society for Testing Materials, Philadelphia, Pa., 1951. Paper 6 × 9 in., 58 pp., diagrams, charts, illus., tables, $1.50. The five papers contained in the first part of this compilation present detailed descriptions of representative, controlled test methods in laundering, wool scouring, metal cleaning, and degerming process. The second part presents a paper on the mechanism of the wetting of textiles with summaries of various test procedures.

PHYSICAL PROPERTIES AND ANALYSIS OF HEAVY WATER. (National Nuclear Energy Series.) By Isidor Kirshenbaum. McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1951. Bound, 6¼ × 9¼ in., 438 pp., diagrams, tables, illus., charts, $5.25. The first two chapters discuss the physical properties of heavy water and equilibrium constants for exchange reactions. The next three chapters cover isotopic analysis by the mass spectrometer and other methods of isotopic analysis of heavy water. The final chapter gives the results of analyses of water from various natural sources to determine isotopic variations. The material is a critical evaluation of the published literature supplemented by a considerable amount of new experimental information.

PLASTICS MOLDING. By John Delmonte. John Wiley & Sons, Inc., New York, N. Y., 1952. Cloth, 6¼ × 9¼ in., 493 pp., diagrams, illus., tables, $9. A detailed treatment of the equipment and methods for the various types of molding processes by which plastic products are formed. Approached from an engineering viewpoint the book considers the flow of materials and the techniques for handling the materials once the flow has been established. This involves not only the molding itself but also the subjects of heat and pressure generation, distribution, and application, instrumentation and control, and plant layout. Specific problems are noted and discussed in connection with each process.

PRAKTISCHE GETRIEBELEHRE. By Kurt Rauh. Volume 1: Die Viergelenkkette. Springer Verlag, Berlin, second edition, 1951. Bound, 6¾ × 10 in., 127, 88 pp., illus., diagrams, charts, 37.50 Dm. In this book mechanisms are discussed not from the point of view of the mathematician or student of theoretical mechanics, but from that of the practical designer of machinery. It is intended to give him a general survey of the possible mechanisms, to show their interrelations and transformations, the effects of changed dimensions, etc., and to illustrate the ways in which they may be applied. Vol. 1 is confined to four-link chains, which are discussed comprehensively. In this new enlarged edition all the illustrations are now in a separate section at the back instead of being interspersed throughout the text as before.

PROCEEDINGS OF A SECOND SYMPOSIUM ON LARGE-SCALE DIGITAL CALCULATING MACHINERY. (Annals of the Computation Laboratory, Harvard University, volume 25.) Jointly sponsored by the Navy Department, Bureau of Ordnance, and Harvard University at the Computation Laboratory, September, 1949, Harvard University Press, Cambridge, Mass., 1951. Cloth, 7⅜ × 10¾ in., 393 pp., tables, diagrams, charts, illus., $8. Of the forty papers presented at the several sessions of the symposium, those of the first two sessions are devoted to discussions of recent developments in computation machinery. The next four groups are concerned with current applications and include papers on numerical methods and on computational problems in physics, aeronautics, applied mechanics, and the economic and social sciences. The volume closes with a discussion of the future of computing machinery.

PRODUCTION PROCESSES. Their Influence on Design. (Machine Design Series.) By Roger W. Bolz. Volume 2. Penton Publishing Company, Cleveland, Ohio, 1951. Bound, 6¾ × 10½ in., 357 pp., illus., diagrams, tables, $7.50. A wide range of manufacturing methods is covered under four broad headings: casting methods—sand, permanent-mold, centrifugal, investment; molding methods—powder, plastics, rubber, ceramics; fabricating methods—welding, brazing; and treating methods—heat-treating, shot peening. Each chapter includes design detailing, material selection, and shop tolerances. Volume 1 dealt with metal working and the production of machine components.

PROGRESS IN PETROLEUM TECHNOLOGY. (Advances in Chemistry Series No. 5.) Edited by the staff of *Industrial and Engineering Chemistry*. American Chemical Society, Washington, D. C., 1951. Paper, 6 × 9¼ in., 392 pp., illus., diagrams, tables, charts, $3. A collection of some thirty papers presented at the Symposium on Twenty-Five Years of Progress in Petroleum Technology, held by the Division of Petroleum Chemistry of the American Chemical Society in 1951. The papers deal with such subjects as catalytic cracking, synthesis of liquid fuels from natural gas, liquid fuels from coal and oil shale, dewaxing and deasphalting, motor fuels, tetraethyllead, lubricants, fuel oil, petroleum, coke and coking, elastomers and plastics, and synthetic detergents from petroleum.

PRUFUNGS- UND UBUNGSAUFGABEN AUS DER MECHANIK DES PUNKTES UND DES STARREN KORPERS. By Karl Federhofer. Part 2: Kinematik und Kinetik des Punktes; Part 3: Kinematik und Kinetik starrer Systeme. Springer-Verlag, Austria, 1951. Paper, 6 × 9¼ in., 103 pp., 139 pp., diagrams, charts, $2.30 each. These two problem books continue a series on applied mechanics, dealing now respectively with the kinematics and kinetics of point-masses and of rigid systems. In each book the problems are given in the first section, followed by a section containing detailed solutions with complete concise explanations of the method of solution.

PULP AND PAPER MANUFACTURE. Volume 2, Preparation of Stock for Paper Making. J. Newell Stephenson, editor-in-chief. McGraw-Hill Book Company, Inc., New York, N. Y. First edition, 1951. Cloth, 6¼ × 9¼ in., 587 pp., illus., diagrams, tables, $7.50. Part of a completely revised four-volume series which is based on a previous five-volume series known as "The Manufacture of Pulp and Paper," the present volume 2 deals with the principles and modern practice of pulping equipment and processes, including preparation of wastes, fillers, loading, sizing, and coloring. Each chapter of this well-illustrated textbook for home study was carefully revised by paper-mill technologists

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

to include materials, methods, and machines in current use.

REVIEWS OF PETROLEUM TECHNOLOGY. George Sell, editor. Volume 2 (covering 1949). Institute of Petroleum, London, England, 1951. Bound, $6^1/_4 \times 9^1/_4$ in., 280 and XXIV pp., tables, 27 s, 6 d. The subjects covered in this extensive literature survey are as follows: petroleum geology, geophysics, drilling and production, chemical and physical refining, cracking and other processes, plant instrumentation, chemistry and physics of petroleum, analysis and testing, crude oils, petroleum gases, gasoline, fuel and insulating oils, bitumen, synthetic fuels, statistics. Some 3000 literature references are given along with the respective chapters. There is an alphabetical name index to the literature references.

SCHNELLSTAHLE UND IHRE WÄRMEBEHANDLUNG. By Willi Haufe. Carl Hanser Verlag, Munich, Germany, 1951. Cloth, $6 \times 8^1/_2$ in., 276 pp., tables, illus., diagrams, charts, 29 Dm. This useful work on high-speed steel and its heat-treatment deals with both the high-tungsten tool steels and with the new steels having a tungsten content of less than 14%. It discusses the influence of the individual alloying elements on steel properties, covers hot-forming and heat-treatment from the consumer's point of view, and includes material on hard-surfacing, tool-tip welding, and the testing and selection of steels and cutting tools.

SPRING DESIGN AND CALCULATIONS. Compiled by John A. Roberts. Herbert Terry and Sons Ltd., Redditch, England, fifth edition, 1951. Cloth, $5 \times 7^1/_4$ in., 125 pp., tables, charts, diagrams, illus., 12 s, 6 d. This small book provides a condensed treatment of the mathematical analysis of the action of all types of springs together with the principles of their design for effective use. Various special applications are described and helpful hints are given for selecting and ordering springs.

DIE STANZEREITECHNIK IN DER FEINMECHANISCHEN FERTIGUNG. By Paul Gabler. Carl Hanser Verlag, Munich, Germany, 1951. Bound, $6 \times 8^1/_2$ in., 202 pp., illus., diagrams, charts, tables, 21 Dm. A practical text on the manufacture of small precision parts on presses. There are three main sections: press-work operations, including design of parts to conform with operating procedures; economic applications of production methods; and systematic tool preparation and maintenance. The book places special emphasis on extrusion-type presses, trimming, and the economic factors involved in multi-step operation.

STUDIES IN LARGE PLASTIC FLOW AND FRACTURE. With Special Emphasis on the Effects of Hydrostatic Pressure. By P. W. Bridgman. McGraw-Hill Book Co., Inc., New York, N. Y. First edition, 1952. Cloth, $6^1/_2 \times 9^1/_4$ in., 362 pp., illus., diagram, tables, charts, $8. During the many years that the author has studied the effect of high hydrostatic pressure on the properties of matter he has observed many fractures under unusual conditions. In this book he presents a coordinated exposition of these observations and the studies he has made on them. Tension, compression, torsion, and shearing-stress tests are reported. Materials studied include steel, aluminum, copper, brass, bronze, glass, beryllium, soapstone, marble, and others. One chapter deals with plastic flow and fracture after prestraining.

SYMPOSIUM ON BULK SAMPLING. Presented at the Fifty-fourth Annual Meeting. American Society for Testing Materials, Philadelphia, Pa. (Special Technical Publication No. 114), 1951. Paper, 6×9 in., 65 pp., charts, tables, $1.75. The papers included in this symposium are concerned with the problems of sampling materials that occur in bulk form or packages with the aim of estimating measurable characteristics with controllable precision. Both engineering and statistical aspects are dealt with. Three of the six papers are on coal sampling.

TENSOR ANALYSIS. Theory and Application (Applied Mathematics Series). By I. S. Sokolnikoff. John Wiley & Sons, Inc., New York, N. Y., 1951. Bound, $6 \times 9^1/_4$ in., 335 pp., diagrams, $6. Tensor theory is first developed without reference to applications, covering linear transformations, matrices, and the algebra and calculus of tensors. Subsequent chapters demonstrate its application to geometry, mechanics, relativity, fluid dynamics, and elasticity, including certain aspects of the deformation of plates and shells. The book is intended to be of interest and use to mathematicians, physicists, and engineers.

THEORY OF ELECTROMAGNETIC WAVES. A Symposium. June 6–8, 1950. Under the auspices of the Washington Square College of Arts and Sciences, The Institute for Mathematics and Mechanics of New York University, and the Geophysical Research Directorate of the Air Force Cambridge Research Laboratories. Interscience Publishers, Inc., New York, N. Y., 1951. Cloth, $7 \times 10^1/_4$ in., 393 pp., charts, diagrams, $6.50. Reflecting the definite revival of interest in electromagnetic problems, the eighteen papers contained in this volume present current approaches by the use of new analytical tools and procedures. Essentially mathematical in character, these papers utilize Green's functions, integral equations, variational techniques, and so on, in dealing with problems concerning wave propagation, wave guides, cavity theory, microwave generation, and similar subjects. This material also appeared in three recent issues of the publication "Communications on Pure and Applied Mathematics."

TREATISE ON MILLING AND MILLING MACHINES. The Cincinnati Milling Machine Company, Cincinnati, Ohio, third edition, 1951. Bound, $6^1/_2 \times 9^1/_4$ in., 910 pp., illus., diagrams, tables, charts, $8. This book presents a general description of the function and operations of milling machines and their accessories as well as the cutting tools used in these operations. Typical examples of actual installations are given to demonstrate proper work handling. The chapters on materials for and types of milling cutters are based on company research. Some forty pages are devoted to the sharpening and care of cutters. Special chapters deal with the power required in milling and with estimating production milling.

TREATISE ON POWDER METALLURGY. By Claus G. Goetzel. Vol. 3, Classified and Annotated Bibliography. Interscience Publishers, Inc., New York, N. Y., 1952. Bound, $6^1/_2 \times 9$ in., 899 pp., $22. Completing a three-volume treatise, the present volume contains the bibliography, comprising nearly 12,000 reference citations divided into two sections covering, respectively, technical articles and patents. Within each section the items are grouped according to a detailed classification system, and arranged chronologically within each classification group. A brief annotation accompanies each reference, and a patent cross index, an over-all subject index, and an over-all name index are provided.

WELDING ENCYCLOPEDIA. Thirteenth edition revised and re-edited by T. B. Jefferson. McGraw-Hill Publishing Co., Inc., New York, N. Y., 1951. Simulated leather, 6×9 in., 1008 pp., illus., diagrams, charts, tables, $7.50. From abrasion to zirconium this standard reference work covers all terms relating to the broad field of metal joining and cutting by application of heat, including heat-treating processes and other allied subjects. Photographs, line drawings, graphs, data tables, and equilibrium diagrams are extensively used to illustrate or amplify the text. Pertinent codes, standards, and specifications are appended, and there is a 90-page list of trade names with descriptive information. The volume has been revised throughout in accordance with current practice.

WELDING OF NON-FERROUS METALS. By E. G. West. John Wiley & Sons, Inc., New York, N. Y., 1951. Bound, $5^3/_4 \times 8^3/_4$ in., 553 pp., illus., tables, diagrams, charts, $8.50. Combining both an insight into the metallurgical aspects of the subject and a practical treatment of the welding process, the author begins with a discussion of weldability and summaries of the fusion, resistance, and pressure welding processes. He then deals, respectively, in a detailed manner, with the welding of aluminum and its alloys; magnesium alloys; copper, nickel, lead, zinc, and their alloys; low-melting-point metals; high-melting-point metals; and the precious metals.

WERKZEUGSPANNER. (Werkzeughalter.) By K. Schreyer. Springer-Verlag, Berlin, Germany, 1951. $6^1/_4 \times 9^1/_4$ in., 331 pp., diagrams, tables, 39 Dm. General principles and detailed descriptions are given of all types of tool-holding devices used in machine-shop practice, with the exception of presswork. Practical aid for the designer and engineer is provided by 865 line drawings of tool-holding devices and methods. A brief chapter is included on materials for tool holders.

WOOD PRESERVATION, During the Last Fifty Years. By H. Broese Van Groenou, H. W. L. Rischen, and J. Van Den Berge. A. W. Sijthoff's Uitgeversmaatschappij N. V., Leiden, Holland, 1951. Cloth, $6^1/_2 \times 9^1/_4$ in., 318 pp., illus., diagrams, tables. $6. Wood preservation is here considered to be the means of preventing attack by living organisms, which organisms are discussed in part A under the headings of fungi, insects, and marine borers. Methods of preservative treatment are also covered in this section, while part B deals in detail with the preservative oils and compounds themselves. Part C lists the research institutes concerned with the subject and gives evaluations of the various preservatives. Extensive reference lists are provided, corresponding to notations in the text.

ZERSPANBARKEIT DER METALLISCHEN UND NICHTMETALLISCHEN WERKSTOFFE. By Karl Krekeler. Springer-Verlag, Berlin, Germany, 1951. Bound, $6^1/_2 \times 9^1/_2$ in., 358 pp., tables, charts, illus., diagrams, 34.50 Dm. A systematic and critical treatise covering materials and methods for machining industrial metals and nonmetals, based on both proved experimental data and industrial experience. Major sections are as follows: materials for cutting and machining tools; testing for machinability; cutting and machining methods and tools; machinability of a wide variety of metals and non-metallic materials; effect of coolants on machinability.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting March 7, 1952, and approved by the Board, May 6, 1952.)

CASE No. 1038–1 (REOPENED)

(Special Ruling)

Inquiry: For dished heads convex to the pressure as shown in Fig. U-18(c), Par. U-73(c) indicates that this construction is permissible on vessels covered by Par. U-70, since the head joint may be regarded as of the lap type. Is this construction also permissible for pressure vessels covered by Par. U-69?

Is it permissible to use shorter lengths of flange (skirt) in dished heads concave to pressure as shown in Fig. U-18(a) and convex to pressure as shown in Fig. U-18(c) than now required by Par. U-75?

Reply: It is the opinion of the Committee that the intent of the Code will be met and vessels may be stamped with the symbol if the following rules are met:

(1) The construction shown in Fig. U-18(c) may be used for pressure vessels under Par. U-69 provided the pressure is on the convex side only and the required shell thickness does not exceed $^{1}/_{2}$ in. The throat of the fillet weld shall be not less than the thickness of the shell.

(2) For the construction shown in Fig. U-18(a) and (c), heads shall have a skirt (flange) not less than $1^{1}/_{2}$ in. long except that when the nominal head thickness is $^{1}/_{2}$ in. or less, the skirt (flange) shall be not less than 3 times the thickness of the head.

Attention is called to the construction of Fig. U-18(b), where the length of skirt (flange) is governed by the requirements of that figure plus the requirement in Par. U-73(a) that the surface overlap for a lap-type joint shall be at least four times the thickness of the shell.

CASE No. 1056–5 (REOPENED)

(Special Ruling)

In *Inquiry*, change reference to Specification "SA-225, Grade B" to "SA-299."

CASE No. 1153

(Special Ruling)

Inquiry: In view of the omission of the new stresses for 5 per cent chromium, $^{1}/_{2}$ per cent moly-titanium steels SA-158, P5c and SA-213, T16 from recent Code revisions to Table P-5 and P-7 of Section I, can stresses from Table UG-23 of Section VIII be used until such time as these stresses are incorporated in Tables P-5 and P-7?

Reply: It is the opinion of the Committee that since stresses for 5 per cent chromium, $^{1}/_{2}$ per cent moly-titanium steels SA-158, P5c and SA-213, T16 were not included in recent Code revision of Tables P-5 and P-7, and since Case No. 1128 has been annulled, which allowed among other things the use of stresses for these materials shown in revised Table UG-23, that stresses from revised Table UG-23 of Section VIII can be used pending incorporation of new stresses for these materials in Tables P-5 and P-7.

CASE No. 1154

(Special Ruling)

Inquiry: May the material of SA-193-51T, Grade B7 be used as bolting material, and if so, what would be the allowable stresses at 950 F and 1000 F?

Reply: It is the opinion of the Committee that bolting made from Specification SA-193-51T, Grade B7 material, the stresses for which are given in Table UG-23, may be used up to a maximum temperature of 1000 F. The allowable stresses shall be as follows:

950 F—8500 psi.
1000 F—4500 psi.

Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisons would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [].

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1949

PAR. P-1(c) Add the following sentence: Material not completely identified with any approved Code specifications may be used in the construction of boilers under the conditions outlined in Appendix Pars. A-95 to A-101, inclusive.

PAR. P-7 Add a second paragraph as follows:

Open hearth or electric furnace steel conforming to Specification SA-306-50T, Grades 50, 55 and 60, may also be used for boiler stays or braces.

PAR. P-115(a)(7) Revise to read:

(7) This construction shall not be used on the rear head of a horizontal return-tubular boiler and inwardly flanged tube sheets shall not be used on a boiler with an extended shell.

PAR. P-115(a) Add the following new paragraph:

(8) On inwardly flanged tube sheets, the length of flange shall conform to the requirements of Par. P-106 and the distance of the outside toe of the outside fillet weld to the point of tangency of the knuckle radius shall be not less than $^{1}/_{4}$ in.

PAR. P-218 Revise first sentence to read:

When stays are required, the portion of the heads below the tubes in a horizontal-return tubular boiler shall be supported by through

stays attached by welding under Par. P-200(c) or with nuts inside and outside at the front head and by attachments which distribute the stress at the rear head.

PAR. P-219 Revise to read:

When stay rods are screwed through sheets and riveted over, they shall be supported at intervals not exceeding 6 ft. Stay rods over 6 ft. in length may be used without support if fitted with nuts and washers or attached by welding under Par. P-200(c), provided the least cross-sectional area of the stay rod is not less than that of a circle 1 in. in diameter.

PAR. A-85 After this paragraph in the Appendix insert the following new paragraphs:

A-95 Unidentified Material. Material not completely identified with any approved Code Specifications may be used in the construction of boilers under the conditions stated in the following paragraphs under this subject:

A-96 If an authentic test record for each plate in its present condition is available, proving it to have properties within the permissible range of an approved SA or SB specification.

A-97 If an authentic test record is not available or there is no marking on the plate positively identifying it with an authentic test record, each plate shall be subjected to the chemical and physical tests required for that grade in the Code specifications[1] with which the plate is to be identified. The additional requirements given below in (a) and (b) shall also be satisfied:

(a) Chemical Tests. Check analysis shall be made from a tension test specimen cut from a corner of each plate. Drillings for these tests shall include the full thickness of the material.

If the corresponding specification is in the SA group and does not require the carbon and manganese contents, determinations of these elements shall be made and recorded. The decision as to whether or not the carbon and manganese contents are satisfactory shall be made by a qualified inspector and shall be acceptable to both fabricator and user.

(b) Physical Tests. When the direction of rolling is not definitely known, two tension test specimens shall be selected from a corner of each plate and at right angles to each other. One of these must yield the specified tensile strength. Similarly, two bend tests shall be made on specimens taken from the centers of adjacent sides of each plate. Both of these must meet the specification. . Steel for which firebox quality is required shall also pass the homogeneity test required by the applicable specification.

A-98 If the plate materials comply with either Par. 96 or 97, the boiler or pressure vessel manufacturer or the testing agency shall stamp or otherwise mark as permitted by the applicable material specification, a serial "S" number on each plate, in the presence of the inspector.

A-99 Suitable report forms, clearly marked as being a "Report on Tests of Non-Identified Material" shall be furnished by the boiler or pressure vessel manufacturer or testing agency, properly filled out, certified by the testing agency and approved by the inspector.

A-100 The qualified inspector shall have the right to accept or reject the testing agency or the test results.

A-101 The requirements for fabrication applicable to the specification to which the non-identified material corresponds shall be followed and the allowable design stress shall be that given in Tables U-2 (P-7) or U-3 for that corresponding specification.

Material Specifications, 1949

EDITORIAL NOTE

The Boiler Code Committee has approved the addition to Section II of the following new specifications with the stress values as recommended: SA-312-51T, Specification for Seamless and Welded Austenitic Stainless Steel Pipe.

(1) The same stress values to be assigned to the same types as have been assigned under specification SA-213.

(2) The same stress values to be assigned to TP 317 as have been assigned to TP 316.

(3) The same stress values to be assigned to TP 309 as have been assigned to plate per SA-167, Grade 8.

It is also recommended that stress values for the welded grade be established as 85% of the stress values for the seamless grades; that the appropriate notes that apply to the several types under Specifications SA-213 and SA-249 should be applied to the types under Specification SA-312; and that, if SA-312-51T is included in Tables P-5 and P-7, the stress values be assigned as outlined above.

SA-333-50T, Seamless and Welded Steel Pipe for Low Temperature Service; with stresses as given in the accompanying table.

Unfired Pressure Vessels, 1950

PAR. UG-98 Replace with the following.

UG-98 Maximum Allowable Working Pressure. (a) The maximum allowable working pressure for a completed vessel is the maximum pressure permitted at the top of a vessel in its normal operating position at the operating temperature specified for that pressure. It is the least of the values found for allowable working pressure for any of the essential parts of the vessel by the method given in (b), and adjusted for any difference in static head that may exist between the part considered and the top of the vessel.

(b) The allowable working pressure for a vessel part is the maximum internal or external pressure as determined by the rules and formulas in this code, including any combination of loadings listed in Par. UG-22 which can occur, for the designated coincident operating temperature, excluding any metal thickness specified as corrosion allowance (See Par. UG-25).

(c) Maximum allowable working pressures may be determined for more than one designated operating temperature using for each temperature the applicable stress value.

PAR. UW-9(d) revise to read:

(d) Stagger of Welded Longitudinal Joints. Except when radiographed 4 inches each side of each welded intersection, vessels made up of two or more courses shall have the centers of the welded longitudinal joints of adjacent courses staggered or separated by a distance of at least five times the thickness of the thicker plate.

Par. UW-10(h) Substitute the following.

(h) Pressure vessels and pressure vessel parts shall be stress-relieved as prescribed in Par. UW-40 when required in the applicable part of Sub-section (C). The joint efficiency permitted for stress-relieved vessels in Par. UW-12 may be applied to any part of a vessel that is stress-relieved. The joints connecting a stress-relieved part to stress-relieved parts shall be stress-relieved. The joint connecting a stress-relieved part to a non-stress-relieved part is required to be stress-relieved only if the thickness of the non-stress-relieved part is equal to or greater than the thickness of the stress-relieved part.

TABLE UW-12 In column under "Limitations" revise last block to read:

For the attachment of heads convex to pressure, to shells not over 5/8 in. required thickness, only with use of fillet weld on inside of shell; and for attachment of heads having pressure on either side, with fillet weld on outside of head flange only, to shells not over 24 in. inside diameter and not over 1/4 in. required thickness.

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[1] Until the several SA specifications can be revised to permit harmless amounts of the residual or tramp elements, the following tolerances are suggested as a conservative guide:

Carbon-silicon steel plate to be fabricated by welding, containing residual chromium and/or molybdenum should have the sum of manganese plus chromium plus molybdenum content no greater than the specified maximum for manganese, when the carbon is not more than 0.35 per cent. This would limit the hardenability of the material to approximately normal expectancy.

	Grade	Tensile Str.	−20 to 650 F	700	750	800
(Resistance Welded)	C	55,000	11,700			
	3	65,000	13,800			
	5	65,000	13,800			

	Grade	Tensile Str.	−20 to 650 F	700	750	800
(Seamless)	C	55,000	13,750	13,250	12,050	10,200

850	900	950	1000
8,350	6,500	4,500	2,500

	Grade	Tensile Str.	−20 to 650 F
(Seamless)	3	65,000	16,250
	5	65,000	16,250

ASME NEWS

With Notes on the Engineering Profession

ASME Semi-Annual Meeting to Be Held in Cincinnati, June 15–19

21 Divisions and 5 Engineering Societies Participating

TWENTY-ONE divisions and committees of The American Society of Mechanical Engineers and five engineering societies will participate in the 1952 ASME Semi-Annual Meeting in Cincinnati, Ohio, June 15–19. A total of 86 papers dealing with almost every field of mechanical engineering will be presented at 38 technical sessions. Headquarters for the meeting will be the Sheraton-Gibson Hotel.

The groups cosponsoring sessions with the ASME are the American Society for Testing Materials, American Society of Lubricating Engineers, Society for the Advancement of Management, American Institute of Industrial Engineers, and Engineering Society of Cincinnati. The last-mentioned body will hold a joint luncheon with the ASME to be addressed by W. W. Tangeman, Mem. ASME, vice-president of The Cincinnati Milling Machine Company. Mr. Tangeman's topic will be "How Cincinnati Engineers Co-Operate."

Papers will be presented in the following fields: hydraulics, gas-turbine power, fuels, petroleum, education, machine design, lubrication, metals engineering, process industries, effect of temperature on properties of metals, power, production engineering, metal cutting, cutting fluids, railroad, heat transfer, industrial instruments and regulators, management, materials handling, and aviation.

Digests of 13 of the papers to be presented at the meeting appear on pp. 503–507 of this issue. Remaining papers will be digested in forthcoming issues of MECHANICAL ENGINEERING.

Effect of World Tension

The effect of international tension on the technical world will be discussed by two speakers. R. J. S. Pigott, President ASME, will address the President's Luncheon on the opening day of the meeting. His topic will be "The Position of the Engineer in These Times." W. C. Foster, Mem. ASME, Deputy Secretary of Defense, will deliver the Society's Roy V. Wright Lecture on "Technology in a Troubled World."

"The Past, Present, and Future of the Italian Power Industry" will be the subject of the Calvin W. Rice Lecture. Piero Ferrerio, chairman and president of the Edison Company, Milan, Italy, will be the lecturer. J. E. Tobey, Fellow ASME, president of Appalachian Coals, Inc., of Cincinnati, will be the speaker at the Semi-Annual Banquet. He will talk on "Romance of Power and Fuels."

Engineering in Management

The Management and Production Engineering Divisions of ASME will sponsor a joint luncheon to be addressed by J. G. Pleasants, vice-president and director of manufacturing, Procter and Gamble, Cincinnati, who will speak on "Engineering in Management."

An entire fuels session will be devoted to the problem of preventing air pollution. Four papers dealing with the design, installation, and application of fuel-burning equipment will be presented. The selection and training of power-plant personnel will come under close scrutiny at a power session for which five papers are scheduled.

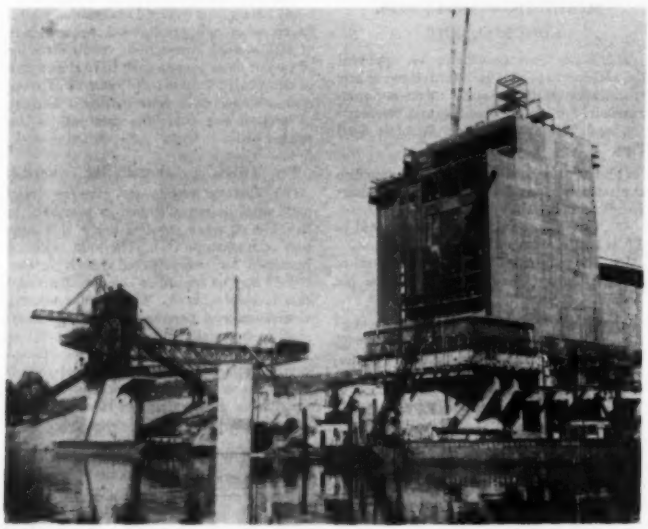
Manpower Problems

The increasing shortage of engineers, of mounting concern to the technical world, will be the subject of a panel discussion entitled, "Engineering Manpower Problems." H. N. Muller, Jr., Mem. ASME, Westinghouse Electric Corporation, will be moderator. Three speakers will delve into the question of what industry has to offer the young engineer, at a junior session.

Plant trips will be made to the Walter G. Beckjord Station of the Cincinnati Gas and Electric Company, The Cincinnati Milling Machine Company, the tube plant of RCA, and the jet-engine plant of General Electric Company. The last-named trip is restricted to U. S. citizens.

Committees

The Cincinnati Section of the ASME will be host for the meeting. G. H. Larkin is general chairman of the committee on arrangements and D. S. Brown is cochairman. R. F. Schierland is secretary. Chairmen of the various subcommittees are: Finance, E. H. Mitsch; hotel, R. H. Howorth; technical events, M. E. Martellotti; reception, E. H. Schubert; entertainment, J. G. Martin; plant trips, H. B. Welge; ladies' activities, F. J. Simonitsch and cochairman, Mrs. F. J. Simonitsch; signs, I. J. Rand; information, registration, and service, E. J. Martin, and publicity, A. L. Kiewit.



WALTER C. BECKJORD STATION OF THE CINCINNATI GAS AND ELECTRIC COMPANY TO BE VISITED DURING THE 1952 ASME SEMI-ANNUAL MEETING, JUNE 15–19

(This is a new generating station being built on the Ohio River 18 miles upstream from Cincinnati. The first unit went into operation in April, 1952. The second unit is scheduled to go into operation in June, 1953, and the third unit is planned for December, 1954.)

24th ASME Oil and Gas Power Conference to Be Held in Buffalo, N. Y.

THE Oil and Gas Power Division of The American Society of Mechanical Engineers will hold its 24th annual conference and exhibit at the Statler Hotel in Buffalo, N. Y., June 23–27, 1952, in co-operation with the ASME Buffalo Section.

The subjects to be discussed during the technical sessions will include papers on engine lubrication, spark-ignition gas engines, crankshaft design problems, and Diesel-engine power plants. The latter session embraces three subjects—Diesel versus steam-power plants, the place of Diesel engines in the REA program, and vapor-phase cooling.

The technical program features a panel discussion on engines of high specific output, subdivided under design improvements in high-output Diesel engines from both the Navy and industrial viewpoints; valves, pistons, piston inserts, and piston rings; and a special view of the piston-sealing problem.

The inspection trips include visits to plants in Buffalo and vicinity such as Worthington Corporation, Niagara Hydro plant, Van der Horst Corporation, and Clark Brothers Company, Inc. A large number of manufacturers of engines, accessories, plant equipment, and services will be represented in the exhibit.

An extremely attractive women's program has been arranged in addition to the banquet, luncheons, and trips.

ASME Applied Mechanics Division Schedules Two Conferences in June

THE 17th National Applied Mechanics Division Conference of The American Society of Mechanical Engineers, including a Symposium on Shock and Vibration Instrumentation, is planned for June 19–21, 1952, to be held at The Pennsylvania State College at State College, Pa., with the co-operation of the ASME Central Pennsylvania Section.

There will be a banquet at the Nittany Lion Inn on June 19 at 7:00 p.m., at which R. E. Peterson, chairman of the Executive Committee, Applied Mechanics Division, will preside. C. C. Furnas, director of the Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., the banquet speaker, will give a talk on the Future Trends in Aviation. Other informal luncheons and dinner are being arranged and plans include a "get-together" at the Centre Hills Country Club.

Inspection trips include the Garfield Thomas Water Tunnel of the Naval Ordnance Laboratory and other laboratory and research facilities on the campus.

Second Applied Mechanics Division Western Meeting

The second ASME Applied Mechanics Division Western Meeting, organized in behalf of the Applied Mechanics Division by the Division's West Coast Committee, is scheduled for June 26–28, 1952, at the University of California, Los Angeles, Calif. The engineering laboratories and facilities will be open to visotors during the meeting.

Western Meeting Features

The fifth annual Heat Transfer and Fluid Mechanics Institute, which will be held at the University, June 24–26, and the Symposium on Earthquake and Blast Effects on Structures, June 26–28, are featured in conjunction with the meeting.

Alexander Heron of Crown Zellerbach Corporation, San Francisco, Calif., will be the speaker at the joint dinner of the Heat Transfer and Fluid Mechanics Institute and the Earthquake and Blast Symposium to be held June 26 at 6:30 p.m. at Kerckhoff Hall on the campus. The subject of Mr. Heron's talk is the Industrial Future of the West Coast.

ASME PRESIDENT PIGOTT RECEIVES EGLESTON MEDAL

[Recipient of Egleston Medal for distinguished engineering achievement (holding citation scroll), R. J. S. Pigott, president ASME, director of the engineering division, Gulf Research and Development Corporation, Pittsburgh, Pa., at the annual dinner of the Columbia Engineering School Alumni Association, April 17, 1952, Columbia University Club, New York, N. Y. With Mr. Pigott are (*right*), John R. Dunning, Mem. ASME, dean of the school of engineering, Columbia University and (*left*) two other graduates of the 1906 class of the school of engineering, the 1946 Medalist, J. K. Finch, dean-emeritus and Renwick professor-emeritus of civil engineering, and the 1950 Medalist, E. A. Prentis, chairman, board of directors, Spencer, White and Prentis.]

ASME Members Honored by Yale Engineering Association

AT the 1952 annual meeting of the Yale Engineering Association, held at The Yale Club, New York, N. Y., on May 1, 1952, Thomas E. Murray, class of 1911S, Commissioner, U. S. Atomic Energy Commission, and Fellow ASME, received the YEA Award for Meritorious Service at the conclusion of an address in which he expressed the hope that the proposed new physics laboratory at Yale University would not only contribute to a fuller knowledge of the great truths to be found in nature and the material universe, but would also advance our understanding of man's spiritual nature and our appreciation of spiritual values.

YEA awards for the advancement of basic and applied science were presented to Warren M. Rohsenow, Jun. ASME, associate professor of mechanical engineering at the Massachusetts Institute of Technology, and to James Lathrop Meriam, associate professor of engineering design, University of California, Berkeley, Calif. This award is conferred on young men holding Yale degrees, in recognition of outstanding achievements made during the first 15 years, or less, after graduation. It will be remembered that Professor Rohsenow was awarded the Pi Tau Sigma gold medal at the 1951 ASME Annual Meeting.

E. Carlisle Hunter, Bankers Commercial Corporation, New York, N. Y., was elected president of the Association to succeed Lawrence W. Bass, past-president, American Institute of Chemical Engineers.

ASME Membership as of April 30, 1952

Honorary Members	52
Fellows	368
Members	13,298
Associates	363
Junior (33 and over)	3,564
Junior (30–32)	2,119
Junior (To the age of 29)	18,123
Total	37,887

AT DINNER MEETING DURING CANADIAN ASME BOILER CODE COMMITTEE CONFERENCE

(*Left to right:* J. H. Taylor, chief boiler inspector, Province of Saskatchewan; A. C. Boardman, Chicago Bridge and Iron Company; Col. H. G. Thompson, assistant general secretary, EIC; Dr. O. W. Ellis, Department of Engineering, Ontario Research Foundation, and chairman, ASME-EIC International Council; J. S. Morrow, chairman, Canadian Standards Association; H. B. Oatley, chairman, ASME Boiler Code Committee; J. T. Crowder, secretary-manager, Canadian Steel Boiler Institute; and W. R. McCaffrey, general manager, Canadian Standards Association.)

ASME Boiler Code Committee Holds First Meeting in Canada

THE Boiler Code Committee of The American Society of Mechanical Engineers held its first meeting in Canada at the Royal York Hotel, Toronto, Ont., April 23–25, 1952. More than 100 attended, of which 65 were Canadians. This meeting was conducted under the sponsorship of the International Council of ASME and The Engineering Institute of Canada of which O. W. Ellis, Mem. ASME, of Toronto, is chairman.

For many years it has been the responsibility of this Committee to establish and maintain the engineering standards applying to the manufacture and installation of all items of mechanical equipment in the United States which are subject to fluid pressure. These standards are now accepted generally throughout both the United States and Canada as well as in many other parts of the world.

W. R. McCaffrey, general manager, the Canadian Standards Association, has maintained close liaison with the ASME Boiler Code Committee for some years in the development of Canadian Standards and Specifications for the design and manufacture of power and heating boilers as well as unfired pressure vessels, piping, and accessories.

The special committee of the Canadian Standards Association which deals with these matters and is under the chairmanship of Joseph Taylor, Regina, Saskatchewan, held its regular meeting on April 21 and 22, and on April 23 the Canadian Committee members met with the ASME Boiler Code Committee.

Among those present at the meetings were representatives of Canadian industry in the boiler-code and unfired-pressure-vessel fields and the chief inspectors of the ten Provinces of Canada, who have accepted the ASME Boiler Code.

The meetings on April 23 consisted of round-table discussions with the Canadian inspectors, which afforded an opportunity for an exchange of views and a question and answer period on many of the Code requirements. On April 24 there were two panel sessions—a morning session dealing with the Power Boiler Code as well as the Heating Boiler Code and an afternoon session on unfired pressure vessels.

The Boiler Code Committee held its regular meeting on April 25. Both morning and afternoon sessions were attended by about 60. There was a full Boiler Code Committee together with a goodly number of members representing the important subcommittees.

In addition, informal luncheons were held on April 24 and 25. On April 24 a reception and dinner was arranged at which some 90 guests and their wives were present.

Dr. Ellis presided on this occasion and other interested bodies were also represented. H. B. Oatley and H. E. Aldrich, chairman and vice-chairman, respectively, of the ASME Boiler Code Committee, were tendered the thanks of all present for making such a successful series of meetings possible. J. G. Morrow, president, and W. R. McCaffrey, general manager, together with Joseph Taylor, were present on behalf of the Canadian Standards Association. The Canadian Institute of Power Engineers was represented by Emmett Briceland, national vice-president, and C. H. Watkins, vice-president, Toronto. The Canadian Steel Boiler Institute was represented by its secretary-manager, J. F. Crowder of Toronto.

Industrial Diamonds

NEW standards for industrial diamonds including specifications, toolholder types, and nomenclature, which will promote standardized diamond usage and can result in practices that will conserve diamonds, are now being developed by a committee initiated by the American Society of Tool Engineers.

A recent meeting in Detroit called by R. C. W. Peterson, Mem. ASME, chairman of the ASTE National Standards Committee, was attended by 25 individuals representing the ASTE, National Machine Tool Builders' Association, Joint Industry Conference, Industrial Diamond Association, Grinding Wheel Institute, Ford Motor Company of Canada, Naval Ordnance, Universal Products Company, and National Diamond Laboratory, Inc.

At this meeting it was unanimously agreed that initial progress toward industrial-diamond standardization could be made now by developing toolholder standards and nomenclature.

ASME-EIC INTERNATIONAL COUNCIL AND ASME BOILER CODE COMMITTEE MEETINGS, ROYAL YORK HOTEL, TORONTO, ONT., CAN., APRIL 23–25, 1952

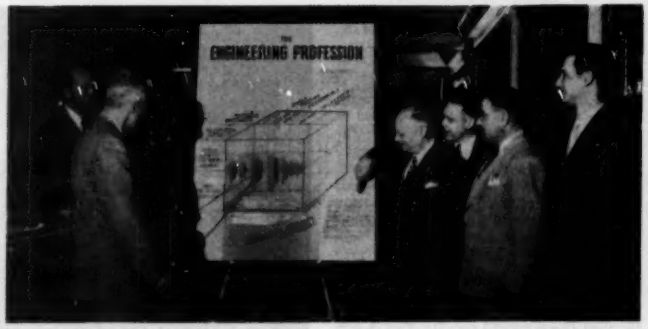
(*Left to right:* Henry Aldrich, vice-chairman, ASME Boiler Code Committee; A. L. Penniman, E. G. Bergman, members, ASME Boiler Code Committee; and H. B. Oatley, chairman, ASME Boiler Code Committee.)

Tau Beta Pi Discusses Unity of Engineering Profession

THE New York Alumni Chapter of Tau Beta Pi, meeting at the Hotel Astor on April 28, 1952, held a forum on the subject "Unity of the Engineering Profession." H. S. Osborne, chief engineer of the American Telephone and Telegraph Company, and secretary of the Exploratory Group to Consider Increased Unity in the Profession, acted as moderator. The four panel members were: E. J. Kates, Fellow ASME, consulting engineer, who representated The American Society of Mechanical Engineers in the Exploratory Group; B. E. Shackelford of Radio Corporation of America, who represented the Institute of Radio Engineers in the Exploratory Group; Alex Van Praag, Jr., of Warren & Van Praag, Inc., who represented the National Society of Professional Engineers in the Exploratory Group; and Roger Wilkinson, past chairman of the Conference of Professional Technical Personnel of the Bell Telephone Laboratories.

Dr. Osborne outlined the history of the movement to unify the engineering profession. In 1949 the Engineers Joint Council invited 16 national engineering societies to designate representatives to form an Exploratory Group which would discuss and recommend means for increasing the unity of the engineering profession. Dr. Osborne pointed out that the approach was unity of the profession which leads to particular emphasis on responsibility of engineers to serve their fellow men, rather than in the manner of a labor union or other collective-bargaining unit. Through greater unity it is believed the engineers can better serve their fellow men, their country, and themselves.

The Exploratory Group evolved four plans of action, designated A, B, C, and D. The Group voted to recommend Plan A as an initial step and the most feasible proposal for getting a unity organization launched at this time, this step to be followed at once by other steps; it has recently issued a report summarizing its conclusions. Plan A contemplates expansion of the Engineers Joint Council to admit to membership all 15 of the engineering societies which participated in the Exploratory Group studies. Thus the plan, if adopted, would not start unifying the profession "from scratch," but will take advantage of the cooperative organization already existing in the Engineers Joint Council. The unity organization, while initially controlled by the member societies, would immediately study the best form and type of individual memberships and membership of local and regional engineering groups.



MEMBERS OF THE PANEL AND MEMBERS OF THE NEW YORK ALUMNI CHAPTER OF TAU BETA PI EXAMINE MR. WILKINSON'S CHART

(*Left to right:* S. M. Babcock, New York Alumni Chapter, Tau Beta Pi; Roger Wilkinson, Elies Elvove, president of N. Y. Alumni Chapter, Tau Beta Pi; E. J. Kates, Fellow ASME; Clifford Curran, vice-president, N. Y. Alumni Chapter, Tau Beta Pi; Alex Van Praag, Jr., and H. N. Seckler, corresponding secretary, N. Y. Alumni Chapter, Tau Beta Pi.)

ASME Represented by E. J. Kates

Mr. Kates expressed his strong approval of the plan recommended. All proposed plans have had a considerable amount of "grass-roots" discussion among ASME members; the results of their discussions, after meetings of local sections, geographic regions, and the national convention, showed this Society to be strongly in favor of the plan to enlarge Engineers Joint Council. Mr. Kates pointed out that the effectiveness of Engineers Joint Council has been demonstrated and cited some recent accomplishments. For example, while engineering has not always been considered as a profession on the level of the legal and medical professions by the U. S. Government, today, partly through the efforts of the Engineers Joint Council, the professional status of engineering has been greatly strengthened by inclusion of appropriate references to the profession in labor, civil service, and military legislation.

Expansion of the Engineers Joint Council from its present membership of five societies to include all 15 societies of the Exploratory Group, according to Mr. Kates, would increase the membership behind the unity organization from the 135,000 now in the EJC societies to a total of 215,000. The basic requirement for success in carrying out any plan of unification is the enthusiastic support by a large number of engineers, including adequate financial support. It should be stressed that the proposed plan is only an initial step, many problems remaining for early solution. One major outstanding problem is that of individual membership. The proposed plan contemplates future study of these problems and for the further development of the plan in any direction desired.

IRE Opinion Reported by B. E. Shackelford

Dr. Shackelford reported that the Institute of Radio Engineers has not yet been able to make up their minds on the proposed plan. Before going ahead with any plan, such questions as the following should first be clearly answered: What is "unity" and why do we want it? Is the purpose of unity primarily to enhance the social standing of engineers, or to increase their earning power? Is the purpose to aid the engineer as an individual, or to aid society as a whole? Would it be better for the unity organization to be controlled by the various engineering societies, or in the charge of the engineers as individuals?

Until these questions are resolved, the IRE feels unable to give wholehearted support to Plan A. Dr. Shackelford stressed that IRE affairs are conducted by its individual members with no regard for corporation managements. Few members of IRE are licensed engineers, while many are physicists, chemists, and the like, and may not always share the same interests as the engineers. While it may be timely to proceed with the Plan A as recommended and try to make the most of it,

THE MODERATOR AND MEMBERS OF THE TAU BETA PI PANEL

it is important ultimately that the control of the unity organization rest in the hands of the individual engineers.

Van Praag Speaks for NSPE

Mr. Van Praag expressed disfavor with Plan A in which EJC would be expanded to include all the national societies, on the grounds that there is not as yet enough agreement among the interested parties to warrant embarking on a unity program. The principal disagreement at present is as to whether there should be a loose-knit co-operation of the societies, per Plan A, or whether the individual engineers should be organized into, and pay dues to, a new society to be patterned after the NSPE. This latter would be similar to Plan D which was supported by the NSPE. Mr. Van Praag pointed out that Plan A proposes in effect that the 15 societies of the Exploratory Group take over the identical professional development field which the NSPE has been successfully cultivating since 1934. The NSPE now has 27,000 members in all branches of engineering in every state in the Union, and is one of the fastest growing of the major national societies.

In successful forms of business, such as corporations, the individual stockholder contributes his money and expresses his views through his voting power. By analogy, Mr. Van Praag argued, the unified engineers' group would be the most successful if the individual engineers were to pay dues and express their views through their voting powers. Thus each engineer would have an individual interest in the unity organization. It was principally this lack of specific provision for individual dues-paying memberships that caused the AIEE to reject the Exploratory Committee's Plan A proposal. (Under Plan A it is assumed that initially the societies would financially support the unity organization.)

Mr. Van Praag stated his firm belief that among the representatives on the Exploratory Group, there was very much less unanimity of sentiment for Plan A than was expressed by the vote at the December 15 meeting of the Exploratory Group. The AIEE is the only society which has conducted an individual membership poll bearing on the subject of what kind of a unity organization and program they would find acceptable; NSPE has come the next closer to this procedure. The individual members should be supreme in deciding this matter of unity, rather than the boards of directors of the national technical societies.

Roger Wilkinson Outlines Professional Interests

Mr. Wilkinson stated that the majority of engineers are perfectly happy to leave the technical-society management in present hands, namely, the higher brackets of engineering management and the deans and department heads at our universities. However, since 75 per cent or more of the 400,000 engineers in the country are employees in the nonsupervisory class, they would surely disapprove (if given the opportunity to vote on the matter) of placing their nontechnical, or professional, interests solely in the hands of the technical-society leaders. Instead, a unity organization should be made up of representatives of all groups in the profession, nonsupervisory and management, younger and older men, and chosen from all branches of engineering.

Mr. Wilkinson showed graphically the extent of technical and professional activity among the various engineering societies. The so-called professional interests include: Service to society, protection of the public, expression of the engineers' viewpoint on appropriate matters, advancement of engineering education in all its phases, continued development of graduate engineers, increase of engineers' prestige and esteem in the public eye, economic welfare of engineers, and co-operation with other professions. Of these professional interests one of the most important today in the eyes of the ordinary engineer is his deteriorating economic status. This is evidenced by the rapid growth of nearly 70 engineering and scientific employees' associations over the country in the past six or eight years. About 25,000 engineers are already in groups certified for bargaining purposes by the National Labor Relations Board. Thus any unity organization which seeks to enlist the enthusiastic support of employee engineers, comprising three fourths of the profession, must genuinely interest itself in problems of satisfactory remuneration, as well as the others on the foregoing list of professional interests.

Mr. Wilkinson urged that the Exploratory Committee resume its deliberations augmented by representatives of employee engineer groups, either as delegates or advisers, to see whether a strong and democratic unity organization can be devised which will appeal to the great majority of the engineering profession.

It was the consensus of the meeting that the open debate of conflicting views had been extremely informative to all those present, and the hope was expressed that similar meetings might be held in the future before other groups, to help clarify the programs for engineering unification and aid in molding one for the best interests of engineers and society. This discussion confirms the fact that the majority of engineers definitely desire a unified organization and that it is essential that the differences in points of view as to how this organization is to be formed be reconciled.

Elies Elvove, president of the New York Alumni Chapter of Tau Beta Pi, served as chairman of the meeting and introduced the moderator and members of the panel.

C. S. PROCTOR, PRESIDENT, *left*, AND T. K. THOMSON, A FORMER DIRECTOR OF THE AMERICAN SOCIEITY OF CIVIL ENGINEERS, JOIN IN THE HANGING OF THE ORGANIZATION'S CENTENNIAL YEAR BANNER IN ITS HEADQUARTERS IN THE ENGINEERING SOCIETIES BUILDING. EACH OF THE SOCIETY'S 77 SECTIONS IS RECEIVING A SIMILAR BANNER

(The Centennial of Engineering will be held in Chicago, Ill., Sept. 3–13, 1952, in conjunction with which the ASME Fall Meeting will also be held in Chicago, with headquarters at the Sheraton Hotel, Sept. 8–11.)

ASME Management Division Plans for Future

THE Management Division of The American Society of Mechanical Engineers needs your help in planning future management programs and division activities. How can the Management Division best serve you? What are your interests in management? What subjects, services, or research material do you expect from the Management Division?

In carrying on the work pioneered in the Society by such leaders as Towne, Taylor, Gantt, Clark, the Gilbreths, and others, the Management Division has brought to the attention of the interested members up-to-date information in the following fields of management: Administration, cost determination, distribution, engineering management, engineering opportunities, executive development, farm management, industrial relations, methods improvement, small-plant management, supervisory training, production planning, quality control, time and motion study, and wage incentives, through the management sessions at the ASME Spring, Semi-Annual, Fall, and Annual Meetings.

In order to continue the development of this constantly searching program of new developments and improvements in management the division seeks the assistance of those employed or interested in the field so they can best serve your needs. What kind of meetings would be of most value and interest? What topics should be discussed?

Send in your suggestions and ideas so that the Management Division may plan meetings of even greater scope and attractiveness—the kind of meetings you would not want to miss. Also, for any further information write to E. H. MacNiece, chairman, ASME Management Division, Director of Quality Control, Johnson and Johnson, 500 George Street, New Brunswick, N. J.

EJC to Participate in Third UPADI Congress

THE Engineers Joint Council formally accepted an invitation to send representatives to the Third UPADI Congress in New Orleans, La., Aug. 25–30, 1952. The delegation will be made up of representatives of each of the constituent EJC societies.

The purpose of UPADI, the Pan-American Federation of Engineering Societies, is to provide an organization which will encompass the engineering societies of both North and South America and promote their activities on an international scale. The New Orleans meeting is the third in a series which began in 1949 in Rio de Janeiro and continued in Havana in 1951. It is anticipated that UPADI will complete its organizational work at the meeting in August.

Representatives of engineering societies of 19 Western Hemisphere countries including the United States and Canada will convene in New Orleans for the meeting. The Congress will be under the leadership of Luis Giannattasio, engineer, of Montevideo, Uruguay. Sr. Giannattasio is president of UPADI. J. M. Todd, past-president ASME and EJC, chairman of the EJC-UPADI Committee, is in charge of arrangements in New Orleans.

In addition to the official delegates, a number of engineers and industrial executives from Latin America, the United States, and Canada are expected to attend. When the Congress adjourns, several of the delegates and observers plan to go to Chicago, Ill., to participate in the Centennial of Engineering, to be held Sept. 3–13, or the ASME Fall Meeting, Sept. 8–11, with headquarters at the Sheraton Hotel.

The facilities of Tulane University have been secured for the meeting. The University will also provide housing and dining rooms.

The tentative program follows:

MONDAY, AUGUST 25

Morning

Registration

Noon

Welcome Luncheon

Afternoon

Plenary Session

Report on developments since Havana meeting. Committee conferences

Evening

Cocktail Party

International House

TUESDAY, AUGUST 26

Morning

Latin-American delegates' papers

Philosophy of engineering education
Problems and plans for expansion of engineering education

Noon

Luncheon

Speaker on Engineering Education

Afternoon

U. S. and Canadian delegates' papers

Philosophy of engineering education
Problems and plans for expansion of engineering education

Evening

Informal Dinner

WEDNESDAY, AUGUST 27

Morning

Plenary Session

Committee reports to be received and acted on.

Afternoon

Plenary Session

Committee reports to be received and acted on. Future plans to be discussed.

Evening

Dinner

THURSDAY, AUGUST 28

Tour of Port of New Orleans and plant trips

FRIDAY, AUGUST 29

Morning

Plenary Session

Final action on reports and resolutions. Appointment of new committees.

Afternoon

Panel Discussion

Engineering aspects of industrial development and financing in Latin America

Evening

Formal Banquet

ASME Calendar of Coming Events

June 15–19
ASME Semi-Annual Meeting. Sheraton-Gibson Hotel, Cincinnati, Ohio
(Final date for submitting papers was Feb. 1, 1952)

June 19–21
ASME Applied Mechanics Division Conference. The Pennsylvania State College, State College, Pa.
(Final date for submitting papers was Feb. 1, 1952)

June 23–27
ASME Oil and Gas Power Division Conference Hotel Statler, Buffalo, N. Y.
(Final date for submitting papers was Feb. 1, 1952)

June 26–28
ASME Applied Mechanics Division, West Coast Conference, University of California, Los Angeles, Calif.
(Final date for submitting papers was Feb. 1, 1952)

Sept. 8–11
ASME Fall Meeting, Sheraton Hotel, Chicago, Ill.
(Final date for submitting papers was May 1, 1952)

Sept. 8–12
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Cleveland Auditorium, Cleveland, Ohio
(Final date for submitting papers was May 1, 1952)

Sept. 22–24
ASME Petroleum Mechanical-Engineering Conference, Hotel President, Kansas City, Mo.
(Final date for submitting papers was May 1, 1952)

Oct. 30–31
ASME Fuels and AIME Coal Divisions Joint Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.
(Final date for submitting papers was June 1, 1952)

Nov. 30–Dec. 5
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers—July 1, 1952)
(For Meetings of Other Societies see page 532)

Research and Development Concerns Surveyed

A MAIL survey of some 500 industrial concerns known to perform research and development is being conducted by the Research and Development Board of the Department of Defense to determine industry's total research and development capacity and the past and potential effect of military call-ups on this capacity, the Department announced.

The result of this survey will be useful in locating possible contractors for the defense agencies and will also be of assistance to industry. For the first time it will be possible to determine, for each industry and for various-sized companies and research staffs, the average expenditure per research engineer and the average percentage of sales spent for research. Data of this type will be used in estimating the manpower needed to carry out budgeted research programs and the amount of research (in dollars) that can be performed by staffs of a given size.

During 1952 the Federal Government will spend more than 1.6 billion dollars for scientific research and development. About three fourths of this amount will be for defense work, the majority of which will be performed by industrial organizations.

People

THEODORE VON KÁRMÁN, Mem. ASME, authority on aviation problems, has been awarded the gold medal of the British Royal Aeronautical Society for his work in aerodynamic theory.

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P. J. GALBREATH, Jun. ASME, head, machine and mechanical design department, Kodak's Tennessee Eastman Company division, Kingsport, Tenn., and C. L. Miller, Jun. ASME, design engineer, lubrication-engineering section, Eastman Kodak Company, Rochester, N. Y., were honored by the American Society of Lubrication Engineers at the society's annual meeting held in Cleveland, Ohio. Mr. Galbreath was awarded the Alfred E. Hunt memorial medal and Mr. Miller received the Hudson award.

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R. T. KNAPP, Mem. ASME, professor of hydraulic engineering, California Institute of Technology, delivered the annual James Clayton lecture before The Institution of Mechanical Engineers, London, England, on April 18. He spoke on "Cavitation Mechanics and Its Relation to the Design of Hydraulic Equipment." He repeated the lecture at an Institution meeting in Edinburgh, Scotland, April 21. While in Great Britain he will visit the Admiralty hydraulics laboratories and the Universities of Wales and Cambridge.

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G. M. KLINE, Mem. ASME, chief of the National Bureau of Standards Organic and Fibrous Materials Division, received the first annual Honor Award of the Washington chapter of the American Institute of Chemists. The presentation was made at a dinner meeting on April 22.

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NEWBERN SMITH, chief of the National Bureau of Standards Central Radio Propagation Laboratory, was awarded the 1952 Harry Diamond Memorial Award for his fundamental work in the field of radio wave propagation. Dr. Smith's work has formed the basis for the practical use of ionospheric observations in the operation of world-wide communication systems.

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R. J. PAINTER was appointed as new treasurer of the American Society for Testing Materials. He succeeds J. K. Rittenhouse, who was retired after 43 years of service with this national technical group.

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B. F. FAIRLESS, president and chairman of the board, U. S. Steel Corporation, Pittsburgh, Pa., has been awarded the John Fritz Medal for 1953. The award will be formally presented to Mr. Fairless during the Centennial of Engineering, Sept. 3–13, 1952, Chicago, Ill.

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J. B. STIRLING, president of E. G. M. Cape and Company, Montreal, Que., Can., has been elected president of The Engineering Institute of Canada for 1952–1953. He succeeds I. P. Macnab, of Halifax, Nova Scotia. Mr. Stirling assumed his new office during the annual meeting of the Institute which was held in the Hotel Vancouver, Vancouver, B. C., May 7–9.

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O. A. WHEELON, production design engineer, Douglas Aircraft Company, Inc., Santa Monica, Calif., was awarded the Wright Brothers Medal by the Society of Automotive Engineers, at the spring aeronautical meeting held at the Hotel Statler, New York, N. Y.

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JULES HALPERN, professor, department of physics, University of Pennsylvania, has been elected chairman of the Federation of American Scientists for 1952–1953. He succeeds Prof. L. B. Borst of the department of physics, University of Utah. The new vice-chairman is Prof. V. F. Weisskopf, department of physics, Massachusetts Institute of Technology, and the secretary-treasurer is Prof. C. D. Coryell, department of chemistry, also of M.I.T. Other members of the FAS Executive Committee named by the Council are D. R. Inglis, physicist, Argonne National Laboratory; W. A. Higinbotham, physicist, Brookhaven National Laboratory; A. H. Shapley, physicist, National Bureau of Standards.

DEPARTMENT OF THE INTERIOR HONORS ENGINEERS

(For ingeniously solving a difficult vibration problem that was destroying the four turbine runners and reducing the output at Parker power plant, two Denver, Colo., Bureau of Reclamation engineers, I. A. Winter, and John Parmakian, Mem. ASME, each received $600. The awards, the largest the Department of the Interior can give for efficiency, were made in line with a departmental program to recognize unusual efficiency, superior accomplishment, and suggestions that save time and money for the government. Mr. Winter, head of the hydraulic-machinery branch, and Mr. Parmakian, an instruments expert in the dams branch, both on the staff of the Bureau's chief engineer, pooled their talents to work out the turbine problem, and saved the government at least one-half million dollars. *Left to right*: John Parmakian, L. N. McClellan, chief engineer Bureau of Reclamation, and I. A. Winter.)

Safety Convention Attracts Large Audience

TEN thousand safety experts and accident-prevention workers from more than twenty states met for the 57 sessions of New York's 22nd annual Safety Convention and Exposition, held at the Statler and New Yorker hotels, New York, N. Y., April 1–4, 1952.

More than 200 speakers and panel leaders brought the latest developments in every field of accident prevention to industrialists, teachers, traffic and law-enforcement officials, fire chiefs, housewives, and other participants in the sessions.

72 Agencies Co-Operate

The convention and exposition were sponsored by the Greater New York Safety Council and 72 national and local co-operating agencies, among whom are Army, Navy, Coast Guard, U. S. Atomic Energy Commission, Red Cross, National Society for the Prevention of Blindness, six departments of the New York City government, three New York State government bureaus, the Eastern Railroads Presidents' Conference, National Board of Fire Underwriters, American Transit Association, American Merchant Marine Institute, American Hospital Association, and chambers of commerce, women's and professional federations, labor unions, and insurance companies.

Among the fields of accident prevention to which entire sessions were devoted for the first time this year was one on the safety problems of driver training schools. For example, the licensing and supervision of driving schools was discussed.

Another "first" this year was the session on safety in radio and television. Radio and television hazards were included last year in the home-safety sessions, but this year the

industry had its own session. Accident control in broadcasting studios was discussed and health hazards of radio and television manufacturing were outlined. There was also a discussion on home-safety problems involving the T-V antenna.

Industrial Dispersion, Waste Disposal, Aviation Safety Covered

Disaster control as a nationwide problem was discussed, both from the viewpoint of dispersal of industries and organizing disaster control in individual plants.

Also for the first time this year, the problems of air pollution, water pollution, and other adverse results of industrial waste disposal were covered.

Conferences were held by leaders in the aviation industry and Government on the safety problems of aviation, from the production plant to the plane at the field and in the air; and by building and highway construction engineers and contractors and building-maintenance and realty men on accident prevention in these fields.

A series of meetings was devoted to waterfront accidents and the problems of safety at sea.

Many safety problems confronting hotel operators were taken up. The sessions enable those responsible for various phases of hotel operation to obtain the benefit of the experience and knowledge of safety experts in all fields.

Problems of hospital, nursing, public health, and industrial health administrators were discussed at a series of meetings. Possible public emergencies and the problems of safety maintenance with limited personnel in some fields were considered.

The reduction of automobile accidents, cause of more than one third of all accidental deaths in the United States last year, was one of the major areas of study and programming.

The 113 exposition booths showed the newest developments in safety equipment, driver testing devices, eye-conservation tests, accident-reduction systems, and other visual displays.

NSF Graduate Fellowships Awarded for 1952-1953

THE National Science Foundation awarded 624 graduate fellowships in the natural sciences for the academic year 1952–1953. The successful fellows were selected from about 3000 applications, from all parts of the United States and its possessions and from American citizens abroad.

The list of awards includes 569 predoctoral fellows and 55 postdoctoral fellows. As required by the National Science Foundation Act of 1950, all fellows were selected by the Foundation on the basis of ability, with awards made in cases of substantially equal ability so as to result in a wide geographical distribution.

Awards were approved by the National Science Board upon the recommendation of Alan T. Waterman, director of the National Science Foundation.

COLUMBIA BASIN SECTION OF ASME HONORED BY PRESENCE OF EMINENT ENGINEERS AT MARCH MEETING OF THE SECTION AT RICHLAND, WASH.

(Shown *left to right* are: W. W. McIntosh, chairman, Columbia Basin Section; G. R. Prout, general manager, General Electric Company Nucleonics Division; R. J. S. Pigott, president ASME and guest speaker; and S. H. Graf, vice-president, Region VII, who introduced the speaker.)

Gray Iron Founders' Society Honored

THE Gray Iron Founders' Society, national trade association for the gray-iron foundry industry, was awarded a Certificate of Co-Operation from the Economic Co-Operation Administration, for furnishing technical assistance to the peoples of the Marshall Plan countries.

The special recognition was given to the society for the role it has played in supporting mutual American-European efforts to strengthen the free nations against communism.

Since 1949 the Economic Co-Operation Administration, predecessor to the new Mutual Security Agency, has been bringing groups of European technicans and specialists to this country to see how our American factories use modern techniques for efficient production.

The Gray Iron Founders' Society is presently assisting a delegation of foundrymen from Portugal. This group arrived in the United States on April 2, 1952.

C. L. Warwick Executive Secretary, ASTM, Dies

C. LAURENCE WARWICK, civil engineer and executive secretary of the American Society for Testing Materials, died April 23, 1952, while presiding at a dinner in honor of the society's retiring treasurer. He was 63 years old.

Mr. Warwick, a resident of Wayne, Pa., was a leader in the standardization movement in this country, particularly in the field of engineering materials. He had served since 1919 as secretary-treasurer and later executive secretary, ASTM, a national organization.

Born in Philadelphia, Pa., he was graduated in 1909 from the University of Pennsylvania, where he served later as assistant professor of structural engineering. During World War II he was chief of the specifications branch of the conservation division of the War Production Board. Later, he also headed the materials branch of that division.

Mr. Warwick was the author of technical papers and reports dealing with properties and tests of engineering materials and especially standardization of specifications and tests.

He was a former vice-president of the Engineers Club of Philadelphia and at one time headed the commission of Radnor Township, Delaware County. He was a member of several national professional organizations.

NMTBA Establishes Speakers' Bureau

THE machine-tool industry is establishing a Speakers' Bureau through which machine-tool executives can be made available as speakers at schools, business, and civic organizations.

The Bureau was announced by W. L. Dolle, president, Lodge and Shipley Company, Cincinnati, Ohio, at the spring meeting of the National Machine Tool Builders' Association at the Edgewater Beach Hotel, Chicago, Ill.

Too few people, Mr. Dolle said, understand what machine tools are and what they do and their relationship to the American standard of living. We believe that the public is interested in knowing more about our industry, which has such a direct bearing upon productivity and national defense.

Organizations interested in obtaining a speaker should write to the National Machine Tool Builders' Association, Cleveland, Ohio.

Meetings of Other Societies

June 2–4
American Gear Manufacturers Association, 36th annual meeting, The Homestead, Hot Springs, Va.

June 16–18
American Society of Heating and Ventilating Engineers, semi-annual meeting, Essex and Sussex Hotel, Spring Lake, N. J.

June 16–20
American Society of Civil Engineers, Denver convention, Cosmopolitan Hotel, Denver, Colo.

June 18–20
Conference on optical methods in industry Institute of Optics. Morning sessions—invited papers by industries; afternoon sessions—round-table discussions, by subject. University of Rochester, Rochester, N. Y.

June 19–20
American Management Association, general management meeting, Waldorf-Astoria Hotel, New York, N. Y.

June 23–25
Forest Products Research Society, sixth annual national meeting, Milwaukee, Wis.

June 23–27
American Institute of Electrical Engineers, summer general meeting, Nicollet Hotel, Minneapolis, Minn.

June 23–27
American Society for Testing Materials, 50th anniversary meeting, New Yorker and Statler Hotels, New York, N. Y.

June 23–27
American Institute of Architects, 84th annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

July 16–17
Institute of the Aeronautical Sciences, annual summer meeting, IAS Western Headquarters, Los Angeles, Calif.

Sept. 3–13
Centennial of Engineering, Chicago, Ill.
(*ASME Calendar of Coming Events see page 529*)

Correction

THE Editor regrets that he "fouled up" the spelling of the name of the eminent physicist James Prescott Joule by failing to note that an "f" had been substituted for a "j," on page 358 of the May number.

Industrial Physics Conference To Be Held in Scotland

THE fourth Conference on Industrial Physics, arranged by The Institute of Physics, will take place in the Royal Technical College, Glasgow, Scotland, June 24–28, 1952. The subject of the conference is "physics in the transport, shipbuilding, and engineering industries." In connection with the conference an exhibition of instruments, apparatus, and books relevant to this subject will be held and more than 70 industrial firms and Government departments have accepted invitations to take part.

The program of the conference includes lectures and discussions on metal physics, meteorology, and education and training of industrial physicists in Scotland, sound reproduction, physics in naval architecture, physics in transport, automatic control of industrial processes, and noise and its suppression.

The conference will be opened by Lord Bilsland, president of the Scottish Council; the principal speakers include Sir Andrew McCance, who is chairman of the Organizing Committee of the conference; and Sir Robert Watson-Watt.

Arrangements have been made to visit the laboratories of the Royal Technical College, Glasgow; the shipbuilding yards of John Brown and Company, Ltd., Clydebank; the Thorntonhall laboratories of the Mechanical-Engineering Research Organization of the Department of Scientific and Industrial Research; the laboratories of the departments of natural philosophy and of physical chemistry, University of Glasgow; the Clydebridge Steelworks of Colvilles, Ltd., Cambuslang; and the North British Locomotive Company, Ltd., Springburn. Sight-seeing trips include a motor-coach tour to Crieff, by way of Loch Lomond, Glen Falloch, Glen Dochart, Loch Earn, St. Fillans, Braco, and Stirling, and a steamer excursion on the River Clyde and Firth of Clyde.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, April 18, 1952

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on April 18, 1952. R. J. S. Pigott, chairman, presided. In addition to Mr. Pigott there were present: H. R. Kessler, R. A. Sherman, and W. F. Thompson of the Executive Committee; E. J. Kates, assistant treasurer, E. G. Bailey, past-president, H. E. Martin, director at large, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Boiler Construction Code

Upon recommendation of the Boiler Code Committee, it was voted to approve changing the name of the "Boiler Construction Code" to "ASME Boiler and Pressure Vessel Code."

Welding Research Council

Also upon recommendation of the Boiler Code Committee, it was voted to contribute the sum of $250 to the work of the Pressure Vessel Research Committee of the Welding Research Council.

Battelle Memorial Institute

An agreement with Battelle Memorial Institute regarding research investigations of the interactions of aluminum, nitrogen, manganese, silicon, and chromium in the graphitization of steam-piping steels, was extended for a six-month period ending Oct. 31, 1952.

It was also voted to extend for a six-month period an agreement with Battelle Memorial Institute regarding a study of the suitability of selected commercially available alloys for use in superheaters at steam temperatures in excess of 1200 F.

Research Contracts

Contracts with Battelle Memorial Institute were authorized for the following studies:

1 Survey of high-temperature properties of chromium-molybdenum steels and the superalloys.

2 Determination of the effect of notches on the fatigue properties of N-155 alloy.

A contract with the University of Michigan, Engineering Research Institute, was authorized for statistical evaluation of creep-rupture properties of heat-resistant alloys.

Resolution of Thanks

A resolution was adopted expressing the thanks of the Society to members of the Western Washington Section and others who contributed to the success of the 1952 Seattle Spring Meeting.

Council Committee on Staff Personnel

After a report from E. G. Bailey on the Council Committee on ASME Staff Personnel, it was voted to designate this committee as the Council Committee on Staff Personnel, with the purpose of reviewing principal staff remuneration. Committee members will include a past-president, two vice-presidents, and two directors.

A working subcommittee was authorized to deal with immediate staff problems. This subcommittee, in addition to the Committee itself, will consist of E. G. Bailey, F. S. G. Williams, and John Haydock.

Metals Engineering Handbook

The signing of a contract with McGraw-Hill Book Company was authorized for the publication of the Metals Engineering Handbook, parts 1 and 3 of which are now completed.

Centennial of Engineering

Authority was delegated to the President and Secretary to deal with the problems connected with entertainment of distinguished foreign guests at the Chicago Fall Meeting during the Engineering Centennial.

Certificates of Award

Certificates of Award were approved for the following retiring chairmen of Sections W. H. Byrne, Metropolitan Section; C. C. Vogt, Washington, D. C., Section; and Thompson Chandler, West Virginia Section.

Upon recommendation of E. S. Theiss, vice-president, Region V, a certificate of award was granted to A. M. G. Moody "in appreciation of his contribution as the organizer of the Westmoreland Section."

A special certificate was approved for E. A. Muller, manager of ASME, 1924–1927, and vice-president ASME, 1927–1929, of Cincinnati, Ohio, in recognition of his 62 years of membership in the Society.

World Power Conference

R. J. S. Pigott and W. F. Thompson, alternate, were designated as ASME representatives to the U. S. National Committee for World Power Conference.

West Point Sesquicentennial

J. L. Walsh, Washington D. C., was designated to represent the Society at the West Point Sesquicentennial Celebration on May 20 as an honorary vice-president.

Forrest Nagler

The death of Forrest Nagler, vice-president ASME, 1948–1950, on April 1, 1952, was noted. A. D. Bailey, J. T. Rettaliata, and J. G. Van Fleet were appointed honorary vice-presidents to represent ASME at the funeral.

Appointments

The following appointments on committees and joint activities were approved: N. C. Ebaugh and Clifford H. Shumaker, Medals Committee; T. H. Wickenden and E. M. Barber, Research Committee; N. G. Schreiner, Boiler Code Subcommittee on Welding; Herman Weisberg, Engineering Foundation; S. F. Spence, National Safety Council, Construction Section; Joseph Pope and A. J. Ackerman, ASME Delegation to UPADI Convention; C. E. Davies and J. W. Cox, alternates.

The following presidential appointments were confirmed:

H. R. Kessler, ASME representative to inauguration of president, Rutgers University; B. T. McMinn, honorary vice-president, ASME representative to annual meeting, The Engineering Institute of Canada; Philip Sporn, ASME representative to Conférence Internationale des Grands Réseaux Électriques; and H. F. Smiddy, ASME representative, National Management Council, Program Committee, Tenth International Management Congress.

Literature

Unfired Pressure Vessels

THE 1951 API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases, Fifth Edition, was recently published by ASME. This edition applies to the design and construction of unfired pressure vessels subject to external pressures and to fusion-welded, riveted, and integrally forged vessels. Provisions are included for periodic inspection, repair, and allowable working pressures for vessels in service; materials to be used in construction are specified; suggestions are given regarding internal structures, corrosion allowance, protective linings, installation of pressure vessels, and design of supports; examples of computations are presented, also data and information useful to designers and inspectors.

The Revision was made by a widely representative committee under the sponsorship of the American Petroleum Institute and The American Society of Mechanical Engineers. In its preparation cognizance was taken of the advances in the field and changes in industrial practices since the publication of the 1943 Code by amplifying and modifying many of the existing rules, and introducing new material, such as: The details for minimum welding required around opening attachments, the acceptance criteria for pressure-relief devices, recommendations pertaining to the use of materials classified as "New," more accurate shell and head design formulas, and the adoption of rules in the ASME Code to provide for high alloy and clad or lined vessels of the several types used.

This 285-page book, published in April, 1952, may be purchased from ASME Order Department for $3 a copy ($2.40 to ASME members purchasing one copy; $3 each for additional copies).

Stainless-Steel Pipe

AN American Standard, Stainless-Steel Pipe, B36.19—1952, cosponsored by the American Society for Testing Materials and The American Society of Mechanical Engineers, was recently published by ASME. This standard has been revised to include the new schedule 5S and in the revised form it gives the wall thickness and weights for schedules 5S, 10S, 40S, and 80S. Copies may be purchased from ASME Order Department, 29 West 39th Street, New York 18, N. Y., for $1 a copy.

Gaskets for Pipe Flanges

AN American Standard, Nonmetallic Gaskets for Pipe Flanges, B16.21—1951, cosponsored by Heating, Piping and Air-Conditioning Contractors' National Association, Manufacturers' Standardization Society of the Valve and Fittings Industry, and The American Society of Mechanical Engineers, was recently published by ASME. This five-page standard is for nonmetallic gaskets for flanged pipe joints, not including cast-iron pipe, covers: types and sizes, material, dimensions and tolerances, and formulas for determining diameters of gaskets for flanged joints. Copies may be purchased from ASME Order Department, 29 West 39th Street, New York 18, N. Y., for $1 a copy.

Porcelain-Enamel Bulletin

THE Porcelain Enamel Institute has completed a revision of its recommended reflectance-test standards for opaque white porcelain enamels. Prepared by the Institute's Quality Development Committee, the bulletin covers apparatus, standards, and procedure, and includes a diagram showing the interrelation of reflectance, reflectivity, and opacity. Tests for both wet-process and dry-process porcelain enamels are described.

Copies of PEI Bulletin T-13, "Reflectance Test for Opaque White Porcelain Enamel," may be obtained for 25 cents from the Porcelain Enamel Institute, 1010 Vermont Avenue, N.W., Washington 5, D. C.

Metal Statistics

THE 31st annual issue of the American Bureau of Metal Statistics Year Book for 1951 will be published in June, 1952.

This is the international survey compiled by the Bureau, which is sponsored by the most important producers of copper, lead, and zinc in the United States and Canada. It records production and other economic statistics on a world-wide basis of copper, lead, zinc, tin, aluminum, antimony, cadmium, cobalt, magnesium, molybdenum, and nickel for 1951 and prior years; also of gold, silver, titanium, and platinum.

The price will be $3 a copy. Advance orders may be entered with the American Bureau of Metal Statistics, 30 Broadway, New York 4, N. Y., at this time and should be accompanied by remittance.

Our Business Heritage

"OUR Business Heritage" is the title of a recent issue of *Business Information Sources*, the official Bulletin of the Business Information Bureau, Cleveland Public Library.

It contains references to articles in print which interpret the American system in business and industry, and lists, among other phases of this "heritage," books, magazine articles, and special reports on the changing perspective of businessmen toward their business responsibilities, business history in the United States, business leadership, selling the idea of free enterprise, teaching the facts of our economic system to employees, and the specific programs of various companies in this field.

Copies of the Bulletin are available for a mailing and handling charge of 10 cents each from: Miss Rose L. Vormelker, Head, Business Information Bureau, Cleveland Public Library, 325 Superior Ave., Cleveland 14, Ohio.

Junior Forum

Conducted by Joseph Schmerler[1]

Government Employs Engineers Too

Where should an engineer look for his first job? This question, foremost in the mind of a senior student, is often answered by industry through representatives and hiring teams which visit the colleges in the spring of each year. Few government agencies, however, use this direct approach in securing the personnel to continue their functions. Generally, a circular posted on the bulletin board is the only notification of available positions. As a result, only a superficial inquiry, if any at all, is made by the student into the possibilities of employment by the government.

In recent articles which have appeared in the Junior Forum concerning job training of graduate engineers, individual work experience of junior members of ASME, and one's responsibility as regards professional development, consideration of the government as an employer has been conspicuously absent.

[1] Design Engineer, Celanese Corporation of America, New York, N. Y. Jun. ASME.

However, when mention is made of the engineering manpower shortage, government and industry appear as keen competitors for the engineers who are available.

In order to effect at least a partial balance in presentation between government and industry, relative to the opportunities and responsibilities of engineers, we invited a government employee, C. T. Miller, Jun. ASME, power engineer, Rural Electrification Administration, Washington, D. C., to write of government as an employer. Mr. Miller had the following to say:

Government Employment

When I submitted the first draft of this article to a friend of mine for review, the first comment I received was, "Are you really sure that the young graduate engineer has a complete grasp of the opportunities in government service?" This made me pause and wonder if there is such a general knowledge of the positions and type of work available in the government.

I believe that most young engineers are faced with the question of becoming a government employee at some time or another. Therefore they should realize that there is a great variety of jobs available in the government ranging from contract engineer, design engineer, and through the various research fields. In addition, there is a great variety of work in the various phases of aircraft, shipbuilding, building construction, the allied design fields of heating, air conditioning and ventilation, power plants of the various types, steam, hydro, and Diesel, as well as research in guided-missile and aircraft experimentation, ordnance, and radar. These are but a few of the fields of work that are available to the engineer in the government. In addition to direct work under the government, there are various laboratories operated by universities with government funds for the purpose of achieving certain goals in experimental fields. There are also authorities such as TVA which hire directly on a basis similar to the government.

Selection of Available Positions

The first step in finding a position is to determine the types of jobs available and their location. This can generally be done by consulting bulletin boards in post offices which post sheets listing positions open and their scale of wages. Another method is consultation with the Civil Service Commission in your area or direct contact with the personnel section of an agency which you consider might have available a position which you desire. In short, search for a job in the same way you would anywhere else. In times such as these the direct approach to the agencies is the best since the Civil Service Commission is allowing a great deal of latitude to the departments in the hiring of manpower.

Before you go to see anyone about a job it might be a good idea if you armed yourself with a couple of the famous "Form 57's" completed with as much data as possible as to your background. This form does not differ to any great extent from the type of application which you would file with any large corporation.

One point should be made clear. That is, that there is likely to be a greater time lag between application for a position and an actual offer from the agency than there is in private industry. This is because there usually is a period for screening of applications.

There are certain material benefits that accrue from government employment. These are: (1) liberal retirement benefits, (2) leaves, both vacation and sick, (3) opportunities for advancement by promotion from within, (4) training courses on an individual agency basis, (5) opportunities to take courses for advancement in one's field, (6) a government-wide executive-training program.

In addition there are other benefits which individual agencies have to offer such as encouragement of engineers to participate in technical-society affairs and availability of technical publications for perusal and reference. One should consider that each agency is a separate entity and will not necessarily function as others function. The individual, in considering the government as an employer, should realize that the government is comparable to many large corporations.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th Street	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Mechanical Engineer, 33, married. Experienced in steam and power economic studies and design for new equipment, operating-costs studies, heat balance, and turbine installation; process-piping, heating, and ventilating. Prefers East. Me-880.

Mechanical Engineer, 45, ME, 1929, Cornell University, 22 years' industrial experience; product design heavy machinery, tool design, machine shop, and stampings plant, methods engineer small parts manufacture. Desires responsible supervisory position. Presently employed. Me-881.

Recent Graduate, BS Industrial Engineering Northeastern University, single, 22. Machine-shop experience, drafting, process planning. Desires methods, time-study, production planning work. Eastern location preferred. Me-882.

Positions Available

Instructor in field of thermodynamics and power. Recent graduate with or without industrial experience if otherwise qualified. Master's work may be pursued while instructing. Also available, a membership in mechanical engineering toward master's degree. Position available September, 1932. $1052. $1200 plus tuition. Upstate N. Y. Y-6849.

Methods Engineer, five years' experience in machine-shop practice and process engineering. Some traveling. $6000–$8000, plus living allowance. Headquarters, New York, N. Y. Y-6910.

General Superintendent, preferably with MS degree in chemical or mechanical engineering, to take complete charge of ammonia sulphate fertilizer plant. Must have had previous experience in charge of large-scale chemical and industrial plant. $15,000–$25,000. India. Y-6930.

Manager of Manufacturing to assume full responsibility for production of interior upholstery as applied to the automotive field. Must be strong executive type with background in cloth and art leather trim. $12,000, plus bonus. Mich. Y-6953-D-7686.

Assistant to Plant Engineer for three sugar factories. Working knowledge of Spanish or ability to learn the language important. $6000–$10,000, depending on experience. Cuba. Y-6959.

Development Engineer, mechanical graduate, at least five years' design and development experience in sheet-metal-products fields, to do development work and product engineering covering metal containers, small tanks, etc. Some traveling. $6000–$7000. Newark, N. J. area. Y-6972.

Administrative Engineer, to 45, mechanical or electrical graduate, several years' experience in development engineering and with administrative experience. Will be assistant to chief engineer responsible for business end of department, i.e., progress reports, control charts, budgetary controls, etc. Salary open. New York metropolitan area. Y-6988.

Industrial Development Engineer, over 30, for procurement department of aeronautical company, to diagnose and evaluate patents, equipment, and latest new developments. Should have minimum of five to ten years' industrial experience. $6000–$8000. New York metropolitan area. Y-6997.

Manufacturing Engineers, 23–32, for trouble shooting technical problems, process improving, equipment, tools, etc., for electronic-tube manufacturer. $4160–$5720. N. J. Y-7018.

Chief Project Engineer, minimum of ten years' experience in design of automatic machinery, as well as product design and development, preferably in the paper-machinery industry. $12,000, plus bonus. Y-7023.

Engineers. (a) Assistant industrial engineer, graduate, at least two years' manufacturing experience in industrial metal-products fields, to plan, develop, and install methods improvements, work-standards, cost-reduction, and control programs. $5060. (b) Assistant to plant engineer, mechanical or electrical graduate, to prepare equipment layouts, specifications, etc., covering mechanical and electrical metal-fabricating equip. $3410–$4205. Eastern Va. Y-7024.

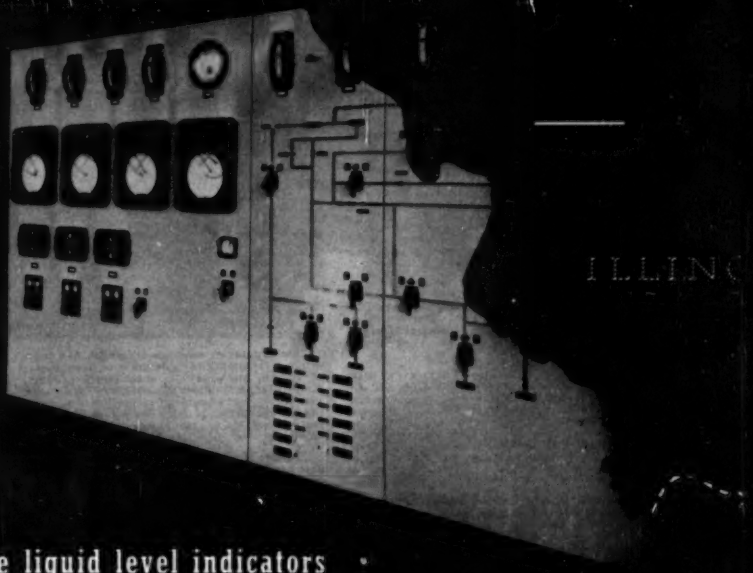
Mechanical Engineer, 45–50, at least ten years' design, production, and management experience in mechanical-instrument field, to take charge of engineering, manufacturing, and new products covering mechanical devices. $10,000, plus bonus. Philadelphia, Pa. Y-7028.

Production Engineer, mechanical degree, at least five years' general machine shop, methods

(*ASME News continued on page 536*)

[1] All men listed hold some form of ASME membership.

The Empire District Electric Company orders and reorders



remote liquid level indicators

YARWAY SERVICE GOES ALL THE WAY

and production-control experience covering paper converting or allied equipment, to be responsible for production control and co-ordination of orders, engineering, and production. $6000–$8000. Newark, N. J. area. Y-7055.

Product-Development Engineer, 25–35, mechanical or electrical preferred, some general business experience desirable. Company manufactures a line of nonconsumer metallic capital equipment used by major oil companies and distributors. Will handle various technical projects from their inception through the development stage until they are ready for product engineering. Work involves design, liaison with the various departments of the factory, such as production, sales, and service, etc. $5500–$8400. Western Mich. Y-7059.

Engineers. (*a*) Development engineers, junior and senior, both electronic and mechanical engineers, for small electromechanical devices. Some experience in facsimile and electronic development desirable. $4160–$7020. (*b*) Design-Draftsman, mechanical, at least three to seven years' experience on small intricate mechanisms. Salary open. New York, N. Y. Y-7061.

Field Engineer, mechanical or aeronautical graduate, for test and development of jets and piston-type engines. Considerable traveling. $4080–$4980. Headquarters, New York Metropolitan area. Y-7063.

Development Engineer, 20–60, for manufacturer of blowers and exchangers. Duties will include heat-transfer problems, blower design, and controls. $5000–$10,000. New York State. Y-7068.

Development or Application Engineer, at least five years' experience in original design and development of electromechanical equipment and/or at least five years' experience in the development and application of precision ball bearings for instrument use. Capable of analyzing customers' design requirements to determine the proper application for the bearings involved. Willing to travel throughout the U. S. about one fourth of time. $6000–$10,000. New England. Y-7069.

Personnel Manager, preferably graduate engineer, about 30, two or three years' experience in personnel, preferably in the process industries. Company employs 700 people. $6000. New York State. Y-7071.

Mechanical Construction Engineer, five to ten years' experience in the installation of mechanical equipment on large construction project. Any experience in airport work desirable. $11,440, including board and maintenance. Turkey. Y-7072.

Machine Designer, five to ten years' experience in the design of medium-heavy automatic machinery. $6500. N. J. Y-7074.

Assistant Chief Engineer, mechanical degree and some additional training in electrical engineering. Must have proved record as a successful administrator and be able to supervise a large staff of engineers in design and development of aircraft accessories. $10,000, and up. Mich. Y-7076.

Assistant Maintenance Engineer, mechanical graduate, either recent graduate or one with two to five years' experience in vegetable-oil refining plant, to assistant in plant engineering and supervise maintenance. Junior, $3600–$4800; senior, up to $6000. Northern N. J. Y-7081.

Mechanical Engineer, graduate, experience on design, specifications, and construction of heating, plumbing, water, and oil supply, etc. $5060. Must be citizen. Long Island, N. Y. Y-7082(b).

Utilities Engineer for laying out and revamping electric, steam, and water-distribution systems; develop maps and easement file; plan for expansion. Present system is 3500-IW steam plant at 650 lb, automatic telephone system and water-treating plant. $8400. Alaska. T-8842.

Salesman, 30–40, mechanical or chemical engineer, four or five years' experience in instrument work, sales, or application. Acquainted with process industries. Knowledge of instrumentation in process fields. Duties will include sales of instruments and service. $4800, and up. Company will pay placement fee. Traveling one third of time; car required. New York area. T-8843.

Chief Engineer, mechanical, 40–50, five years' or more experience in fabrication or development of special machinery or sheet-metal products. Knowledge of stainless steel helpful. Will supervise, direct, and administer inspection of engineering and production of dairy equipment for a manufacturer of dairy machinery. $9000–$12,500. Company may negotiate fee. Iowa. R-8841.

Master Mechanic, up to 50, five years' experience in plant engineering or master mechanic in general manufacturing. Knowledge of maintenance, fuel, boilers, and electricity. Will do general plant engineering for a manufacturer. $9000. Ill. R-8863.

Chief Engineer, 35–50, four years' experience in plant engineering for food packaging. Knowledge of production-line operations. Will take charge of all engineering for food-packaging equipment such as refrigeration, high-pressure steam equipment, pumps, blowers, process piping, automatic machinery, etc., for food manufacturer. $7200. Company will negotiate placement fee. Ill. R-8884.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after June 25, 1952, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

AYAN, GEORGE O., Wilmington, N. C.
BARNES, NORMAN S., Philadelphia, Pa.
BARTO, JOHN L., Seymour, Conn.
BECK, FRANK, East Orange, N. J.
BELLO, G. LUIS A., Bogota, Colombia, S. A.
BEMISS, ALBERT O., San Francisco, Calif.
BOROWCZYZK, JAN, Hamilton, Ont., Can.
BOUVIER, LOUIS, Reynolds, N. C.
BRAND, H. R., Jr., Forest Hills, L. I., N. Y.
BRENT, HANS W., Huntington, W. Va.
BROOKS, FRANKLIN E., Topeka, Kan.
BUNSEL, H. F. W., Berwick, Pa.
CALVERT, FLOYD, Tulsa, Okla.
CARPENTER, B. L., Tulsa, Okla.
CARROLL, RAYMOND E., Ann Arbor, Mich.
CERNE, PHILIP J., Willowick, Ohio.
CLARK, JAMES, Webster Groves, Mo.
COAKLEY, JOHN E., Elisabeth, N. J.
COFFMAN, W. R., North Kansas City, Mo.
CRAWFORD, ROBERT W., Youngstown, Ohio
CROFT, D. R., Houston, Texas (Rt)
DAVIS, STEPHEN S., Washington, D. C.
DEDIALLA, J. SINGH, R. J. Kharagpur, India
DELUCA, P. E., Bridgeport, Conn.
DEROO, ROBERT L., Philadelphia, Pa.
DEVALLE, CLEMENTE, Bogota, Colombia, S. A.
DOWD, HENRY S., New York, N. Y.
DURAND, R. A., East Chicago, Ind.
EINFELD, ERNEST M., San Francisco, Calif.
FEARING, DEXTER E., Chattanooga, Tenn.
FOEHRINGER, HARRY J., Euclid, Ohio
GELBETZ, AVIGDOR, Tel-Aviv, Israel
GRIMM, ARTHUR P., Paoli, Pa.
GLEASON, JAMES G., Fayetteville, Ark.
GOGAN, CHARLES J., Ho-Ho-Kus, N. J.
GRAHAM, H. M., Pittsburgh, Pa.
GROSHOLZ, JAMES R., Hatboro, Pa.
HALL, KENNETH P., Hempstead, N. Y.
HARRIS, DON A., Oak Ridge, Tenn.
HASSELRIIS, FLOYD, New York, N. Y.
HATCH, GERALD M., Winesburg, Ohio
HESS, GEORGE K., Jr., Cambridge, Mass.
HICKEY, JOSEPH J., Baltimore, Md.
HIGGINS, RODNEY B., Port Arthur, Texas
HOH, DAVID H. C., Iowa City, Iowa
HOLTHAUS, CLARENCE F., Jr., Parlin, N. J.
HOPKINS, VERNICE, Kansas City, Mo.
HORN, JACK H., Houston, Texas
HUFFMAN, L. T., Bartlesville, Okla.
IBRAHIM, MUHAMMED, Karachi, Pakistan, India
JOHNSEN, ERIK P., New York, N. Y.
KALLAS, GEORGE A., Canton, Ohio
KANE, JOHN M., Baltimore, Md.
KAO, S. C., Taipei, Taiwan, Formosa (Rt & T)
KEEVER, H. G., Grand Prairie, Texas
KOUBEK, FRANCIS J., Baltimore, Md.
LEVESQUE, GEORGE N., Providence, R. I.
LOGUE, JOHN M., Lancaster, Pa.
LUTZ, WILLIAM E., Philadelphia, Pa.
MARSHALL, J. G., Anaheim, Calif.
MAST, B. T., Houston, Texas
MARTINEZ S. FAUSTINO, Cartagena, Colombia, S. A.
MCGUIRE, BERNARD J., Chicago, Ill.
MCLAUGHLIN, GEORGE J., Bethpage, N. Y.
MIAN, AMIR, A., Ottawa, Ont., Can.
MILLER, WILLIAM R., Bloomington, Ill.
MOORE, DEREK W., Burnley, Lancashire, England
MOSELEY, S. C., St. Catharines, Ont., Can.
MULLEN, JOHN S., Crawford, N. J.
NURSE, LOUIS W., Knoxville, Tenn.
OGDEN, ROBERT W., Jr., Dallas, Texas
OSBORN, WILLARD J., El Cerrito, Calif.
OUTWATER, JOHN O., Wilmington, Del.
PANJA, J. E., Arlington Heights, Ill. (Rt & T)
PAYNTER, HENRY M., Reading, Mass.
PERKINS H., EDWARD, Jr., New Haven, Conn.
PFISTER, PHILIP C., Morgantown, W. Va.
POWER, THOMAS H., Port Arthur, Texas
RANDLEMAN, VERNEER P., Corvallis, Ore.
REYNOLDS, GEORGE O., Jr., New York, N. Y.
RIDDLE, HOWARD S., Charleston, W. Va.
RIKER, ROBERT L., New York, N. Y.
RILEY, RICHARD E., Massillon, Ohio
RING, EUGENE, Akron, Ohio
RITTER, ARTHUR A., Santa Rosa, Calif.
ROBBA, WILLIAM A., Oak Ridge, Tenn.
RODRIGUEZ M. LUIS E., Bogota, Colombia, S. A.
RUTKOWSKI, EDWARD J., Buffalo, N. Y.
SAHI, B. D., Hirakud, Orissa, India
SANDERSON, WILLIAM M., Cuyahoga Falls, Ohio
SANDHU, PRITPAL SINGH, Amritsar, East Punjab, India
SCHAFFER, HERMAN W., Erie, Pa.
SCHIBLER, CHARLES F., Philadelphia, Pa.
SCOTT, ROY, Jr., Tulsa, Okla.
SHAW, ROBERT H., East Hartford, Conn.
SHRIER, PHILIP, Shawinigan Falls, P. Q., Can.
SMITH, R. Q., Lower Hutt, New Zealand
SMITH, RICHARD W., Cedar Falls, Iowa
SOPWITH, D. G., East Kilbride, Glasgow, Scotland
STAPLETON, PATRICK G., Maywood, N. J.
SUTTON, GEORGE E., Gainesville, Fla.
TAMBURRINO, ANTHONY, Oakland Gardens, N. Y.
THOMPSON, J. WALTER, Wayne, Pa.
TOBEY, JULIAN E., Jr., Cincinnati, Ohio
TOURTELLOTTE, MILLS C., Harvey, Ill.
VANCE, HARLEY E., Wilmington, N. C.
VARGAS S., HERNANDO, Bogota, Colombia, S. A.
VAUGHN, E. L., Uxbridge, Mass.
WATTS, W. H., Lakewood, Ohio
WEBER, ERIC R., Milwaukee, Wis.
WEISS, WILL H., Moline, Ill.
WENDT, FREDERICK W., Columbus, Ohio
WIGGS, JAMES, Long Beach, Calif.
WOODHALL, EDWIN S., Gadsden, Ala.
ZWIACHER, WAYNE E., Chicago, Ill.

CHANGE IN GRADING

Transfers to Member and Associate

ALLEN, PHILIP, Drexel Hill, Pa.
ANDERSON, R. LARS, West Lafayette, Ind.
BUTLER, HOWARD W., Storrs, Conn.
CABLE, H. E., Pittsburgh, Pa.
CAMPBELL, ROGER P., Kansas City, Mo.
CARR, HENRY R., Mt. Airy, Philadelphia, Pa.
CHELGREN, WILLIAM J., Parkersburg, W. Va.
FISCHER, G. KENNETH, Wyncote, Pa.
FRYLING, GLENN R., Brooklyn, N. Y.
GOODNOW, JOHN M. Greenbush, Mass.
GOSS, ROBERT J., Clark, Rahway, N. J.
HARPER, ROBERT S., Hamden, Conn.
HUNTER, ARTHUR T., Montgomery County, Pa.
LASLEY, JAMES B., Lancaster, S. C.
LILLY, C. A., Jr., Atlanta, Ga.
LUNQUIST, ELMER C., Iowa City, Iowa
MACCREHAN, W. A., Jr., Lodi, N. J.
MATTHEWS, NOEL H., Rochester, N. Y.
MCBRIDE, EDWARD J., Dumont, N. J.
OLES, HERBERT E., Buffalo, N. Y.
OLIVER, CHARLES E., Sharon, Mass.
RICHARDSON, HARRY D., Ruston, La.
ROGERS, BENJAMIN T., Jr., Los Alamos, N. Mex.
SCHUMANN, EDWARD A., Jr., New Haven, Conn.
STONE, RICHARD G., Denver, Colo.
WELLS, EDWARD H., Jr., Darien, Conn.
WOODHULL, ALBERT S., Lexington, Mass.
YOUNG, JAMES W., Hollidaysburg, Pa.

Transfers from Student Member to Junior 700

Obituaries

David Arthur Cant (1899–1952)

DAVID A. CANT, owner, Cant Manufacturers Representatives, Tulsa, Okla., died March 3, 1952. Born, Chicago, Ill., Aug. 4, 1899. Parents, David T. and Lucile C. (Barnes) Cant. Education, high-school graduate; attended evening school for 4 years. Married Eva Ferguson, 1947. Mem. ASME, 1951. Survived by wife.

(*ASME News continued on page 538*)

GUARD AGAINST EXPLOSION with R-C INERT GAS GENERATORS

Portable R-C Inert Gas Generator used for purging operations and stand-by protection in large gas-producing plant. Capacity 15,000 cfh.

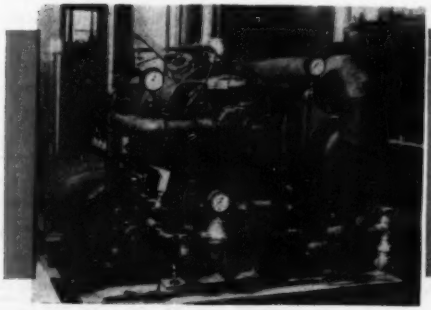
If your operations involve materials or processes which might cause an explosion-produced fire, you can reduce the risk with R-C Inert Gas Generators. In many instances, the relatively small cost is absorbed by savings in insurance costs.

These mobile or stationary units instantly produce a continuing flow of inert gas, for use in purging gas or liquid lines, blanketing dangerous areas and for many other industrial uses involving the handling or storage of explosive materials.

R-C Inert Gas Generators are compact, simple and inexpensive to operate, with either oil or gas as fuel. They are available in capacities from 1,000 cfh to 50,000 cfh, with characteristics to match specific requirements.

Where even a relatively low explosion hazard exists, one incident might produce a disastrous fire. Ask for details on how such dangers may be averted with R-C Inert Gas Generators.

ROOTS-CONNERSVILLE BLOWER DIVISION
526 Michigan Avenue, Connersville, Indiana



Installation of three R-C Inert Gas Generators similar to this one helped one large plant save $6,000 per month insurance premiums, as well as substantially reduce danger of production losses caused by explosion or fires. Capacity of each unit, 6,000 cfh.

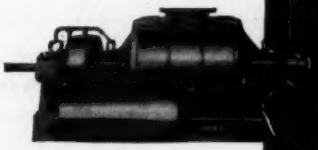
ROOTS-CONNERSVILLE BLOWER
A DIVISION OF DRESSER INDUSTRIES, INC.

THE *DUAL-ABILITY* LINE OF MODERN EQUIPMENT TO HANDLE GAS AND AIR

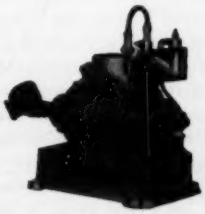
Multi-Stage Centrifugal Exhausters

Single-Stage Centrifugal Blowers

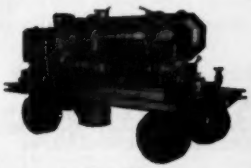
Rotary Positive Blowers



Rotary Positive Gas Pumps



Positive Displacement Motors



Inert Gas Generators

Philip Stephen Fisher, Jr. (1921–1951)

PHILIP S. FISHER, JR., Lieutenant Commander, U. S. Navy, Test-Pilot Training School, Naval Air Station, Patuxent River, Md., was killed in an aircraft crash, March 8, 1951. Born, Haddonfield, N. J., March 19, 1921. Parents, Philip S. and Claire (Johnson) Fisher. Education, BS(ME), University of Pennsylvania, 1951. Married Carol Linnea Youngren, 1945. Jun. ASME, 1944.

Deane Stanley Hazen (1892–1952)

DEANE S. HAZEN, president, High Standard Manufacturing Corp., Hamden, Conn., died March 8, 1952. Born, Windsor, Vt., Dec. 7, 1892. Parents, George T. and Eva M. (Harding) Hazen. Education, BS, Dartmouth College, 1915; MCS, Tuck School of Business Administration, 1916. Married Lucille L. Swing, 1919. Jun. ASME, 1921; Assoc. Mem. ASME, 1926; Mem. ASME, 1935.

Henri Biering Lenau (1883–1952)

HENRI B. LENAU, mechanical engineer with Roy M. Henwood Associates, New York, N. Y., died March 30, 1952, at his home in Scarsdale, N. Y. Born, Copenhagen, Denmark, May 9, 1883. Parents, Emil and Ellen Lenau. Education, ME, University of Copenhagen, 1905. Naturalized U. S. citizen, 1919. Married Ellen Christensen, 1908. Mem. ASME, 1922. Survived by wife and daughter, Mrs. Helen B. Ackermann.

Francesco Mauro (1887–1952)

FRANCESCO MAURO, president, Societa Italiana Ernesto Breda, Milan, Italy, died Feb. 14, 1952. Born, Domodossola, Italy, March 3, 1887. Education, Ginnasio-Liceo, 1904; Politecnico, Milan, 1909; Dr.Ing (EE), 1909. He was honorary president, CIOS; author of several books. Mem. ASME, 1947.

Henry Parker Merriam (1863–1952)

HENRY P. MERRIAM, retired mechanical engineer, died in Hubbardston, Mass., Feb. 28, 1952. Born Lawrence, Mass., June 5, 1863. Parents, James F. and Mary (Davidson) Merriam. Education, BS, Massachusetts Institute of Technology, 1886. Married Eliza Sprague, 1924 (died 1934). Jun. ASME, 1887; Mem. ASME, 1896. Survived by cousin, Mrs. William E. Clough, Hubbardston, Mass.

William Moeller (1876–1952)

WILLIAM MOELLER, retired, chief engineer, Lone Star Cement Corp., Dallas, Texas, died Feb. 24, 1952. Born, Copenhagen, Denmark, Sept. 8, 1876. Parents, Mr. and Mrs. Jens Bertel Moeller. Education, ME, Technical Institute, Copenhagen, Denmark, 1901. Naturalized, U. S. citizen, Dallas, Texas, 1920. Married Ellen Clausen, 1906; son, Jens Edwin. Mem. ASME, 1917.

Alexander Willett Moseley (1869–1952)

ALEXANDER W. MOSELEY, retired mechanical engineer of Evanston, Ill., died Feb. 28, 1952. Born, Lynn, Mass., Sept. 23, 1869. Parents, George D. and Alice K. (Willett) Moseley. Education, BS, Massachusetts Institute of Technology, 1891. Married Elizabeth Braydon, 1916; children, Alexander W., Jr., Merritt W., Elizabeth. Mem. ASME, 1900.

Forrest Nagler (1885–1952)

FORREST NAGLER, retired, manager and chief engineer of Allis-Chalmers atomic power section, died April 1, 1952, at Lake Forest, Ill., Born, Freeport, Mich., April 21, 1885. Parents, John G. and Helen (Moore) Nagler. Education, BS(ME), University of Michigan, 1906. Married Aletta Seefeld, 1911. Invented the Nagler type of axial-flow high-speed hydraulic-turbine runner; also held many patents in the hydraulic-turbine field. Contributed to technical press and engineering journals. His major work was described in ASME Transactions, December, 1919, for which he was awarded life membership in the Society. During World War II he was one of the experts named to witness the second (underwater) atomic burst at the Bikini atoll. His chief atomic assignment was in the development of heavy electromagnets used to separate uranium 235 from pitchblende. Mem. ASME, 1918; Life Mem. ASME, 1921; Fellow ASME, 1950. He served as regional vice-president, Region VI, ASME, 1949–1950. He was a member of the Hydraulic Division, Executive Committee, 1937–1938, and chairman of that Committee 1939–1940. He was a sponsor of the Committee on Hydraulic Prime Movers. Survived by wife, a son, John W., South Miami, Fla.; a daughter, Mrs. Mary H. Meyer, Pewaukee Lake, Wis.; and two brothers, Victor and LaRue.

James Edgar O'Hagan (1904–1950)

JAMES E. O'HAGAN, executive vice-president, Allied Record Manufacturing Co., Inc., Hollywood, Calif., died Jan. 10, 1950, according to a report recently received by the Society. Born, Pittsburgh, Pa., March 23, 1904. Education, graduate, Hyde Park, Chicago, Ill., 1922; attended University of Illinois, 1923–1924; Northwestern University, 1930–1933. Assoc. ASME 1946.

Will Miller Sawdon (1873–1952)

WILL M. SAWDON, professor emeritus, experimental engineering, College of Engineering, Cornell University, died in Ithaca, N. Y., April 1, 1952. Born, Aurora, Ind., Jan. 1, 1873. Parents, George W. and Anna R. (Miller) Sawdon. Education, BS(ME), Purdue University, 1898; MME, Cornell University, 1908. Married Adelaide Frances Wilder, 1902; children, Lura J., Agnes P., Esther M., Edith A., George W., and Will W. Mem. ASME, 1910. Served the Society as chairman, Ithaca Section, 1937–1940. He was Mayor of the City of Ithaca, 1924–1925. Author of several technical papers and commercial reports.

Leigh Willard (1880–1951?)

LEIGH WILLARD, whose death was recently reported to the Society, was president of Interlake Iron Corp., Cleveland, Ohio. Born, New Berlin, N. Y., Feb. 14, 1880. Parents, Marcus S. and Emma E. (Allendorf) Willard. Education, student Providence (R. I.) Manual Training High School, 1894–1897; DE (honorary), Michigan College of Mines and Technology. Married Ellen P. Proberg, 1905; children, Katrize A. (Mrs. Colyer Garre), Ellen E. (Mrs. Robert Lockwood). Assoc. ASME, 1907; Mem. ASME, 1910.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult reverse side of card for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting your address, business connection, and Professional Divisions enrollment is printed on this page. Please use it to keep the master file up to date.

Four weeks are required to complete master-file changes.

New Membership List in Preparation

Please be sure to include your present business title and name of company. See box below.

ASME Master-File Information

(Not for use of student members)

Please print — **Check mailing address**

Name ..... (Last) (First) (Middle)

Home address ..... (Street) (City) (Zone) (State) ☐

Name of employer .....

Address of employer ..... (Street) (City) (Zone) (State) ☐

Product or service of company .....

Title of position held .....

Nature of work done .....

Please register me in three Professional Divisions as follows:

1 .....

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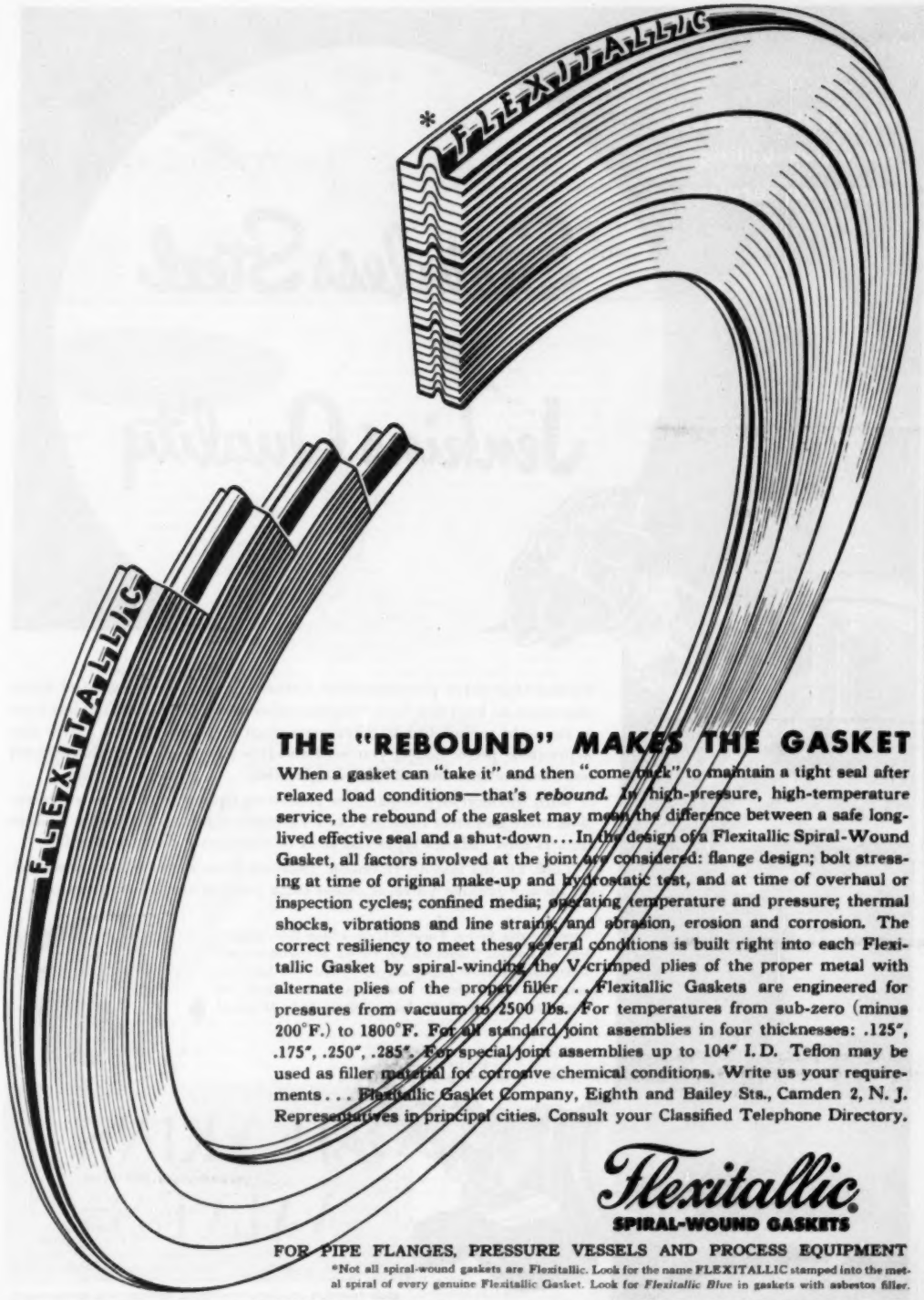
3 .....

(Processing of address change requires four weeks)

I am a subscriber to (please check)

Transactions ☐ Journal of Applied Mechanics ☐ Applied Mechanics Reviews ☐



THE "REBOUND" *MAKES* THE GASKET

When a gasket can "take it" and then "come back" to maintain a tight seal after relaxed load conditions—that's *rebound.* In high-pressure, high-temperature service, the rebound of the gasket may mean the difference between a safe long-lived effective seal and a shut-down... In the design of a Flexitallic Spiral-Wound Gasket, all factors involved at the joint are considered: flange design; bolt stressing at time of original make-up and hydrostatic test, and at time of overhaul or inspection cycles; confined media; operating temperature and pressure; thermal shocks, vibrations and line strains; and abrasion, erosion and corrosion. The correct resiliency to meet these several conditions is built right into each Flexitallic Gasket by spiral-winding the V-crimped plies of the proper metal with alternate plies of the proper filler . . . Flexitallic Gaskets are engineered for pressures from vacuum to 2500 lbs. For temperatures from sub-zero (minus 200°F.) to 1800°F. For all standard joint assemblies in four thicknesses: .125", .175", .250", .285". For special joint assemblies up to 104" I. D. Teflon may be used as filler material for corrosive chemical conditions. Write us your requirements . . . Flexitallic Gasket Company, Eighth and Bailey Sts., Camden 2, N. J. Representatives in principal cities. Consult your Classified Telephone Directory.

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

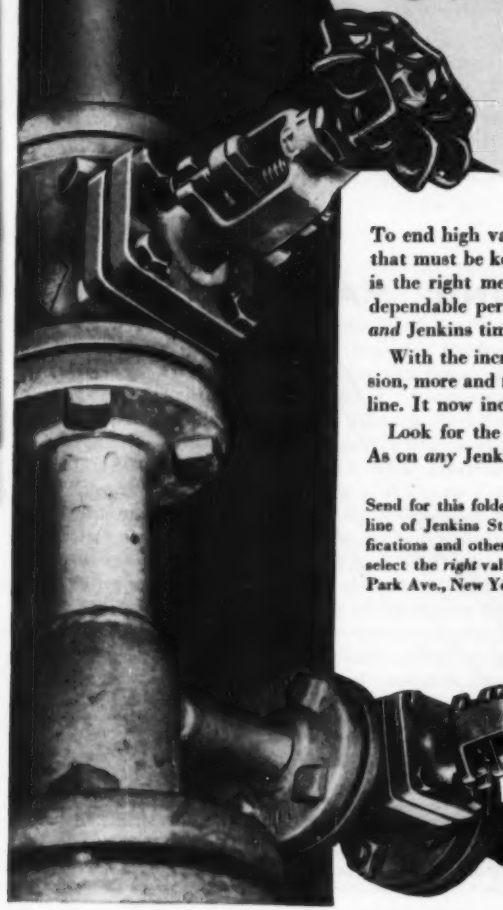
*Not all spiral-wound gaskets are Flexitallic. Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for *Flexitallic Blue* in gaskets with asbestos filler.

Here's the hookup for valve-killing corrosive services...

Stainless Steel

PLUS

Jenkins Quality



To end high valve mortality from corrosive liquids, and to control fluids that must be kept free from contamination or discoloration, stainless steel is the right metal. But it takes more than metal to make a valve. For dependable performance, you need the two-way hookup—Stainless Steel *and* Jenkins time-proved Valve Engineering.

With the increased demand for processing equipment that resists corrosion, more and more Stainless Steel Valves have been added to the Jenkins line. It now includes types and sizes to meet most industrial needs.

Look for the famous Diamond trade-mark on valves of stainless steel. As on *any* Jenkins Valve, it means extra years of trouble-free service.

Send for this folder, Form 194, describing the complete line of Jenkins Stainless Steel Valves. It contains specifications and other important data that will help you select the *right* valves for your plant. Jenkins Bros., 100 Park Ave., New York 17, Jenkins Bros., Ltd., Montreal.

JENKINS VALVES

LOOK FOR THE DIAMOND MARK

SINCE 1864

TRADE JENKINS MARK

SOLD THROUGH LEADING INDUSTRIAL DISTRIBUTORS EVERYWHERE

Keep Informed

ANNOUNCEMENTS OBTAINED MOSTLY FROM ADVERTISERS IN MECHANICAL ENGINEERING AND ASME MECHANICAL CATALOG

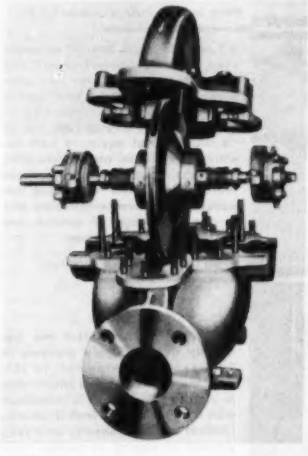
New Equipment *Business Notes* *Latest Catalogs*

Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

New Equipment

Horizontal, Split-Case Pumps

The use of standard mechanical shaft seals, instead of conventional stuffing boxes, thereby obtaining savings in floor space, shorter shaft lengths, improved performance characteristics, and easier pump servicing, is the outstanding feature of a new line of horizontal, split-case, general service pumps recently announced by Peerless Pump Div., Food Machinery and Chemical Corp.



This line of pumps, designated as the Peerless Type AS, is available in discharge sizes from $1^1/_2$ through 4 in. Capacity range is up to 750 gpm and head range is up to 230 ft. General application is for pumping water and clear liquids up to 200 F where no solids are in suspension.

By use of standard mechanical shaft seals, instead of conventional stuffing boxes, the manufacturer states that the pump shaft of the Type AS pump is shortened to $^1/_3$ the length of shafts in conventional pumps of the same size. As a result, the Type AS shaft is more rigid and shaft deflection is materially reduced. This results in smoother, quieter operation and substantially longer life for bearings, seals, and wearing surfaces. Seals used in this pump design are of standard manufacture and are available from standard sources of supply.

In addition, the use of seals has eliminated, in the Type AS design, stuffing box housings. As a result the Type AS pump, it is stated, occupies approximately $^1/_2$ the floor space required by other types of general purpose pumps of the same size. Benefits from reduced size include better accessibility to piping, control equipment and valves, lowered construction costs for pump room, or more pumps in the same amount of space utilized for pumps of conventional design. Several points higher efficiency has been attained by the Type AS pump, compared with conventional pump, size for size. This has been effected, the manufacturer declares, without sacrificing any of the basic design features required in a premium quality pump.

Additional features of construction of Type AS pumps are fully described and illustrated, together with pump cross-section, elevation and plan drawings and dimensional data, in a new bulletin, No. B-1350, copies of which may be obtained from Peerless Pump Div., Food Machinery and Chemical Corp., 301 West Ave. 26, Los Angeles 31, Calif.

Universal Amplifier

Now available for delivery is a new Universal Amplifier (carrier type), designed for use in standard 19-in. rack and having a 7-in. front panel. Designated as Model BL-360 by the maker, The Brush Development Co., the instrument was designed for use with the Brush Magnetic Direct Writing Oscillographs in studies of static or dynamic strains up to 100 cps when measured by the use of resistance sensitive strain gages. Pressures, temperatures, torque, accelerations, and forces may be recorded with these instruments when sensed with the appropriate pickup device.

The Model BL-360 was designed for use with the SR-4 120 ohm strain gage but may be used with any gage type with ohmic resistance of 50 to 1000 ohms. Provision is made for operating one to four active gages. The measurable range of the instrument is 10 to 40,000 microinches per in. with one active gage. The sensitivity is increased 4 times by the use of four active gages.

The control panel contains a 10-step attenuator, terminals for connection of strain gages, calibration resistor holder, resistance and capacity bridge balance controls, gain controls and pen centering control. The amplifier contains a 2000-cycle bridge energizing oscillator, high-gain a-c amplifier, phase sensitive discriminator and DC output amplifier. Provision is made to permit the use of the d-c output amplifier section as a separate unit. An input jack is supplied for this purpose.

A detailed description of this amplifier may be obtained from The Brush Development Co., Instrument Div., 34D, 3405 Perkins Ave., Cleveland 14, Ohio.

Regulating Valve

A new double seated diaphragm regulating valve for use with control instruments has just been announced by Lealie Co., Delafield Ave., Lyndhurst, N. J.

The new valve, "Class DV" has been developed to meet all the features required by the various process industries. It provides, as standard equipment, features heretofore only obtainable in expensive, specially designed valves.

Among the principal features of the new valve is its "Flow-Line" contoured body. This has been designed to provide ISA standard face-to-face dimensions with the highest capacity, lowest turbulence, and body pressure drop. The large bowl construction provides smoothly contoured, full area passages.

Renewable interchangeable seat rings is another important feature of the new valve. These rings are machined so accurately that they can be removed and replaced without removing the valve body from the pipe line. This simplified maintenance eliminates the expensive practice of removing the body from the line and setting it up in a lathe to replace the seat rings. It also eliminates elaborate grinding operations at high temperatures.

An important feature where maintenance may be performed by inexperienced help is the renewable self-aligning guides. These top and bottom guides cannot bind regardless of bolt tightening because they are self-aligning.

The new valve is available in sizes from $1^1/_2$ to 10 in., for pressures up to 600 psi, with screwed ($1^1/_2$ and 2 in.) and flanged ($1^1/_2$ to 10 in.) ends.

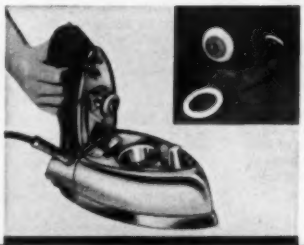
*stays elastic
...in oven heat or arctic cold

Here are just three examples of how Silastic is being used to improve products and to cut production and maintenance costs.

Such applications are practical because Silastic is the only kind of rubbery material that retains its physical and dielectric properties at temperature extremes ranging from —100° to over 500°F. It is most serviceable as a gasketing material at both high and low temperatures and in contact with hot oil.

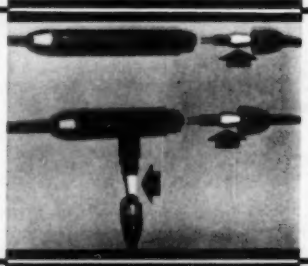
It is the only resilient insulating material that is not damaged by long exposure to the heat generated in overloaded traction motors. It gives long and reliable service as an insulating material for Navy control cable and for ignition cable in aircraft and ordnance vehicles. Silastic also repels water, and shows remarkable resistance to oxidation and to outdoor weathering.

Silastic has properties that may easily suggest some sales-making ideas or cure a production headache for you. Mail coupon today for new data on the properties, performance and applications for all Silastic stocks.



Silastic seals and gaskets are used to seal steam chambers in domestic steam irons because Silastic is insoluble in water, odorless, stainless and resilient at operating temperatures ranging up to 500°F. Life testing and field experience indicate that Silastic seals will retain their resilience for the normal service life of the iron.

Photo courtesy Rival Manufacturing Co.



All connections in aircraft antennae used to be individually spliced and taped. That tedious task has been eliminated, and static and corona discharge have been reduced by as much as 90% through the use of "Anstat" fittings equipped with Silastic seals. These seals retain their dielectric properties and exclude moisture and dust after long exposure to outdoor weathering and to the full range of ground and stratospheric temperatures.

Photo courtesy Fredric Flader, Inc.

Silastic pads and rollers are frequently used to apply pressure in heat sealing equipment. In this machine, for example, a Silastic ring is used to band cosmetic containers with a ribbon of gold leaf. It remains resilient and nonadhesive after long periods of service at surface temperatures above 400°F.

Photo courtesy Elden Manufacturing Co.

DOW CORNING CORPORATION
Dept. No. Q-18, Midland, Michigan

☐ Silastic Facts No. 10 on properties and performance.
☐ List of Silastic Fabricators.

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____

*T. M. Reg. U.S. Patent Office

DOW CORNING SILICONES

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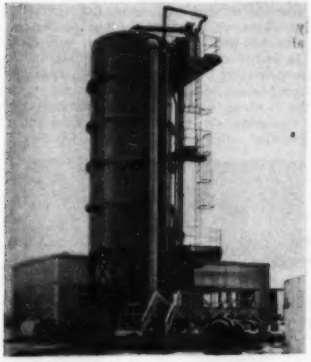
Vacuum Deaerator

Engineered to a high degree of efficiency is the new Vacuum Deaerator, recently marketed by The Permutit Co., 330 West 42 St., New York, N. Y. This unit removes oxygen and free carbon dioxide from the water so as to protect piping, steel tanks, and other equipment from the harmful effects of corrosion.

The most frequently used method of deaeration for steam boilers is to raise the temperature of the water to the boiling point to make all gases insoluble and to scrub the boiling water with fresh steam. However, if the water is to be used cold, it is more practical to lower the boiling point by carrying out the process under vacuum in the Vacuum Deaerator.



These Vacuum Deaerators can be used for a variety of purposes, some of which are outlined below.

Removing oxygen and carbon dioxide from surface water supplies which may be pumped great distances to point of use. Corrosion of such distribution lines may be harmful and especially so if the pipes are exposed to the sun so that the water becomes partially heated.

Removing oxygen from waters used for unit coolers for condensing units for air conditioning and other cooling systems and removing oxygen and carbon dioxide from water which may subsequently be heated in tubular heaters or heat exchangers.

Removing oxygen or carbon dioxide from demineralized or chemically treated water to prevent corrosion of steel piping. Other uses include the removal of gases from demineralized water used in ice manufacture, bottling beverages and from caustic or other liquors where these gases are objectionable in the manufacturing process.

In operation, water is sprayed into the deaerator shell maintained under a vacuum or at an absolute pressure approximating the boiling point. Pressure in the unit is held at 29.75 in. with respect to a 30-in. barometer when deaerating water at 40 or 50 F respectively.

The entering water is distributed over the top surface of a stack of trays or other packing such as Raschig rings. This packing subdivides the water particles repeatedly to expose new water surfaces to the gaseous phase. The noncondensable gases and water vapor are then drawn upwards through the packing and removed by vacuum pumps or steam ejectors.

New di-acro POWERSHEAR

OFFERS
CONTINUOUS ACTION
plus
VARIABLE SPEED
from 30 to 200 strokes per minute

for high speed DIE-LESS DUPLICATING

The new Di-Acro POWERSHEAR has remarkable speed and accuracy for the production of small parts.

1. CONTINUOUS SHEARING ACTION — no clutch to engage! Feeding speed determines shearing speed.
2. VARIABLE SPEED — cycle quickly set for each shearing operation.
3. EASE OF OPERATION — fatigue is reduced, production soars.
4. "SINGLE STROKE" SHEARING — non-repeating safety clutch for jobs not adaptable to continuous shearing.

Any plant doing high speed precision shearing on smaller parts cannot afford to be without the DI-ACRO POWERSHEAR. Available in 12" and 24" shearing widths, capacity 16 gauge sheet steel. Also standard model.

DOES PRECISION WORK ON ALL SHEARABLE MATERIALS

MICA	LEATHER	ALUMINUM	STAINLESS STEEL
PLASTICS	SILVER	SILICON STEEL	and Many
BIMETALS	MAGNESIUM	CHROME MOLY	Other Materials
FIBRE	COPPER	LEADED BRASS	

SEND FOR 40 PAGE "DIE-LESS DUPLICATING" CATALOG
giving full details on Di-Acro Powershears, also Di-Acro Benders, Brakes, Rod Parters, Notchers, Rollers and Punches.

O'NEIL-IRWIN
308 8TH AVE. LAKE CITY, MINN.

This continual removal of gases scrubs the oxygen and carbon dioxide from the surface of the water and produces a higher partial vapor pressure in the lower part of the packing. The higher the partial vapor pressure the lower will be the oxygen and carbon dioxide partial pressure, and therefore the less will be their solubility.

Nonferrous Tube Mills

The Yoder Co., Cleveland 2, Ohio, after several years of experimental and test work, have successfully developed a machine for producing electrically welded tubing of the principal nonferrous metals. These include practically all aluminum alloys available in coiled sheet form, copper alloys, various brasses, nickel, monel, inconel, and stainless steels.

The process employed produces with high weld efficiency a tube comparable in quality to conventional resistance-welded steel tubing. At present, Yoder is offering three sizes of mills which have a total capacity range of 3/4 to 8 in. diameter, on metal thicknesses ranging from 0.025 in. up to 0.140 in.

Welding speeds of 50 to 90 fpm are practical. This represents an increase of 1000% or more over previous methods of welding these alloys, with a generally superior weld quality.

Printed literature is not available at this time, but The Yoder Company will submit information on receipt of inquiries covering specific materials and sizes of tubing to be produced.

Concentrator

Niagara Blower Co., 405 Lexington Ave., New York, N. Y., is building an improved model concentrator for the drying agent used in the company's controlled humidity method of air conditioning.

This method uses a drying agent to absorb moisture from air directly, reducing humidity without refrigeration; therefore it is applied to increase the performance of existing air-conditioning systems as well as to processes and industries where materials are dried or protected from atmospheric moisture—foods, chemicals, lithography, textiles, metallurgical, electronic, and other apparatus and instruments.

The drying agent is a liquid (Hygrol which has hygroscopic properties that afford control of the relative humidity of the area or process that is conditioned. As it is diluted by the moisture it absorbs, a part of the liquid is pumped to the concentrator. In the concentrator this moisture is continuously removed so that the air conditioning is always operating at full capacity.

In the new model, the diluted liquid is sprayed into an air stream over heating surface which raises its temperature, evaporating the water from it. The air stream then passes through eliminator plates which remove the liquid drops. Then, in a second stage, it passes over a cooled reflux coil which raises the relative humidity in the chamber, condensing the absorbent vapor. In the third stage (the "economizers") it passes through filtration cylinders each of which contains a fog nozzle. Here the building up of very high humidity completes the condensation of the absorbent liquid and its droplets are caught by the filters while the moisture-laden air passes through. The reconcentrated absorbent drains to the tank in the base from which it returns to the air-conditioning unit, completing the cycle.

Using this method, which is patented, the consumption of liquid absorbent has been reduced to a point where it is of no importance in practical operations. It is successfully applied to a large-scale air-conditioning and

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REQUIRE NO MAINTENANCE

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BACKLASH FRICTION WEAR and CROSS-PULL are eliminated
Lubrication is not required!

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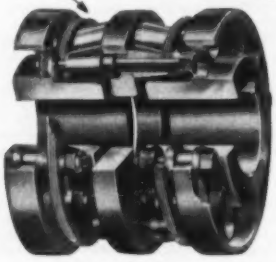

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.

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drying system involving high concentrations. In one installation where the charge of liquid was 2000 gal there was no measurable consumption of liquid in 168 hours continuous operation.

Reducing Welding Time

Welding time on large turbine condensers at the Sunnyvale, Calif., plant of the Westinghouse Electric Corp. has been cut 70% by positioning the condensers. Originally, all welding operations were performed with the condenser in one position. The results were satisfactory, but the all-position welding required was time-consuming.

The condenser now is positioned first on one side, and then the other, thus eliminating all vertical and overhead welding. The condenser, plus the strongback weighing about 35 tons, is positioned with an overhead crane having an auxiliary hook to hold the condenser in its unbalanced position while cribbing and blocking is moved into place.

By positioning the condenser for downhand welding, larger electrodes can be used, and fewer passes are needed per joint. This means not only a higher deposition efficiency, but less time spent cleaning away slag between passes.

In addition to the time saved, the welding job has a more uniform appearance throughout, and some of the cramped and uncomfortable positions of the welders are eliminated, making the job less fatiguing.

The time spent in positioning the condenser is negligible compared to the more than 500 welding hours saved on each unit.

High-Vacuum Pump

A compact new high-vacuum conversion pumping unit of large capacity for use with conventional rotary exhaust machines in the electronic tube manufacturing industry has been announced by Distillation Products Industries.

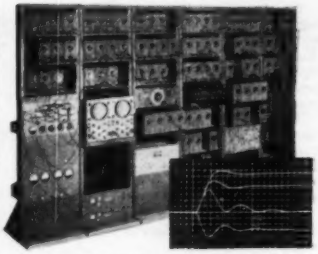
The new unit—the D.P.I. MB-10 Pump, Valve and Port Assembly—is designed specifically to evacuate standard electron tubes. However, it can also be used to pump other relatively small volume containers such as hermetically sealed relays, vials, instrument control elements, and vacuum condensers. For evacuating larger volume vessels or when back-filling operations are desired, a modification of the new unit will permit small solenoid valves to be incorporated. This permits the inclusion of a "roughing" stage in the cycle, practically eliminates pump oil deterioration and loss, and provides a simple means for introducing measured amounts of gases into the evacuated vessel.

Since the new MB-10 Pump, Valve and Port Assembly has a high forepressure tolerance of 400 microns, this eliminates the need for major conversion changes in installations of this new equipment. The pump will operate through most standard sweep and sliding valve combinations.

The pump operates at a pumping speed of 10 liters per sec between 0.1 and 10.0 microns Hg. It also offers ultimate vacuum of 5×10^{-6} mm Hg which provides a wide performance range for over-all flexibility of application.

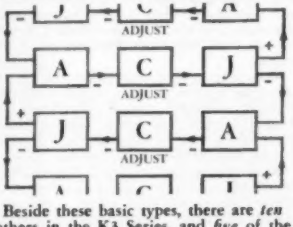
Detailed information concerning the physical characteristics of the pump and its specific adaptability to various conditions may be obtained on request from Vacuum Equipment Dept., Distillation Products Industries, Div. of Eastman Kodak Co., Rochester 3, N. Y.

HOW YOU CAN "BUILD" AN AUTOMATIC ELECTRONIC
Analog Computor
WITH THE GAP/R SERIES OF
Components



Perhaps you need an assemblage this size for solving 36th-order differential equations, or possibly the equipment in the left-hand rack alone will suffice. In either case your "building blocks" are provided by our standard *Computing Components*. Shown below in order are the Adding, Coefficient, and Integrating Components (A, C, and J), the three most popular units in the GAP/R K3 Series:

Even with these types alone you can synthesize, and display solutions for, any linear structure or problem, whether in mechanical vibrations or electric circuitry. In fact, your block diagrams will *come to life*, whatever the job. For example, note here the typical usage of A, C, and J Components to represent operational elements in an important form of recurrent structure:



Beside these basic types, there are *ten* others in the K3 Series, and *five* of the larger and more specialised K4 models. Taken in combination, the components of these versatile assortments can embody any conceivable dynamic effect. Full data on GAP/R analog techniques are available in our latest catalog.

Investigate!

These little "black boxes", and the computing systems easily assembled from them, can magnify your brainpower and diminish your time scales They are fast, accurate, economical, and ready & willing to work (on *your* problems).

George A. Philbrick Researches, Inc.
230 Congress Street, Boston 10, Mass.

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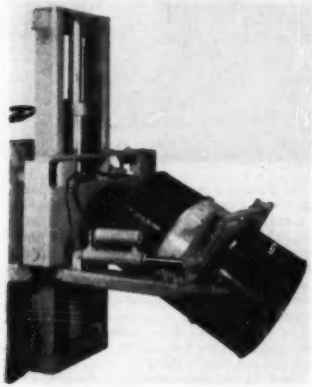
Hydraulic Drum Up-Ender

An economical hydraulic drum up-ender attachment which permits fork-truck operators to pick up, transport, stack, and empty heavy drums without leaving their seat, has been developed by Baker-Raulang Co., 1250 W. 80 St., Cleveland, Ohio. Drums can be rotated 90 deg for vertical or horizontal stacking, or tilted 45 deg below horizontal for emptying at any height within the lift range of the truck.

The up-ender adds a rotating "fifth purpose" to Baker's famous 4-purpose carriage which already provides standard forks, fork-spacer, an automatic adjusting clamp and side-shifter in one unit. Demounting the unit is simple—remove two lock pins, unsnap one quick-detachable hydraulic hose coupling, and slide the up-ender off the forks.



The attachment consists of shoes which are "pinned" to the forks of the Baker 4-purpose carriage. Mounted on the shoes are pivoted rubber-faced grab plates which clamp around the drum and hold it firm. The up-ending operation is accomplished through a hydraulic cylinder mounted on one of the shoes. Operation of the hydraulic cylinder builds up pressure in an actuating accumulator mounted above it, which is used to return the drum to an upright position.

In addition to the quick-demounting feature, an important advantage is that the operator maintains complete control from his seat. Clamp and tilt controls are dash-mounted at his left for convenience.

Both the 4-purpose carriage and the hydraulic up-ender can be mounted on 2000, 3000, and 4000-lb Baker fork trucks.

Electronic Printing Press Drive System

Design improvements in General Electric's electronic printing press drive system which reduce the space required for the equipment and permit safer, more convenient operation have been announced by the company.

Introduction of a rotary selector switch, replacing knife switches formerly used in G-E press control, permits simplified motor selection. Through the use of the versatile switch, only one adjustment, instead of the three required previously, selects field, armature, control stations, and dynamic braking for the units in operation.

The switch also allows electrical isolation of the units now in use.

Another new feature is a control design utilizing only three cubicles. Since four were needed previously, this reduces control length per folder to approximately 8½ ft, providing a space reduction of over two feet.

Despite this shorter length, all functioning components of the control have been maintained in their normal locations except the autotransformer. This equipment is now mounted, enclosed, near the source of incoming power, permitting additional savings in copper and cost of installation.

"Water Saving" Air Conditioners

New installation, operating, and maintenance economies are features of a completely new line of medium-tonnage, self-contained air conditioners, with integral evaporative condensers, introduced by The Trane Co., La Crosse, Wis. Designed to meet the most stringent municipal regulations on water consumption and disposal, the new air conditioners will be produced in 15 and 20 ton capacities. This capacity range serves a broad variety of medium-sized offices, supermarkets, banks, restaurants, stores and other commercial and industrial applications. The units are designed to meet year-round air conditioning requirements, delivering conditioned air through a duct system.

Complete design, specification and installation data are contained in bulletins S-362-A and D-362, available from The Trane Co.

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- Action-packed . . . production-boosting 16mm films for your next technical meeting, training school program or production clinic.
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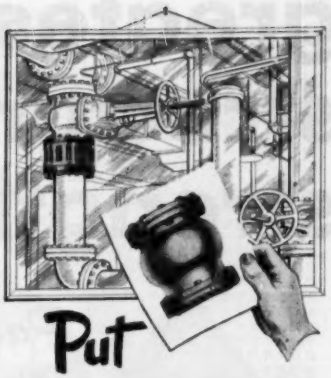


Put WILLIAMS-HAGER flanged Silent CHECK VALVES into the Picture-

and your WATER HAMMER WORRIES ARE OVER

When you install Wiliams-Hager flanged Silent Check Valves in your water system, you complete the happy picture of a plant . . . rid of costly water hammer. These dependable valves provide positive protection in any position including angular, horizontal and vertical with flow either upward or downward. Disc and seat are renewable—conical spring is non-wearing. Easy to install or reseat, they are available in standard pipe sizes from 1" to 20".

CHECK VALVES

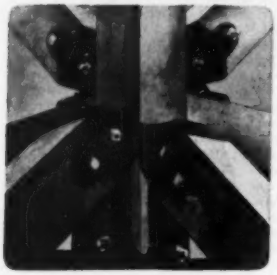
Write for Bulletin WH 851

Write today for your copy of this informative bulletin on Water Hammer, its Cause, Effect and Control in Piping Systems.

THE WILLIAMS GAUGE CO.
3019 PENNSYLVANIA AVE. • PITTSBURGH 33, PA.

greatest structural strength...

with WCEC *Patented* Cast Iron Timber Connectors



By use of WCEC connectors, the struts develop their strength as a column by direct bearing on the square end of the strut against a cast iron seat. The connectors spread the horizontal component of the stress in the strut over a large area of the vertical columns, to assure that the allowable resistance of the wood in compression perpendicular to the grain will not be exceeded. The vertical component of the stress is transferred to the vertical column in direct end grain bearing, through shear bars on the timber connector. These patented connectors develop the greatest structural strength of the timber joints, an accomplishment almost impossible to achieve by bolting alone. WCEC cooling towers directly in the path of hurricanes have withstood the test of extreme wind load without damage.

SEE OUR CATALOG IN SWEETS FILE

TOWERS OF STRENGTH WCEC

Typical installation at Bloomingdale's, New York City. Other WCEC towers at Gimbel Brothers, Pittsburgh; Scruggs-Vandervoort-Barney, St. Louis; Sears-Roebuck, Chicago; J. C. Penney Co., St. Louis.

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Giant Pump

A giant and a pygmy are posed side by side for a study in contrasts at the Fairbanks-Morse pump plant in Beloit, Wis. Despite the vast difference in size, both are pumps of the same model, the largest and the smallest of their type.

The giant is a 54-in. Figure 5720 angleflow pump with a massive casing twice the height of a man and has a top capacity of 80,000 gpm. It is being built for service in the Brownsville, Texas, Irrigation District. Driven by a 420-hp Fairbanks-Morse Diesel, it will pump 86,000,000 gal of water per day from the Rio Grande River into irrigation channels.

The pygmy also is a Figure 5720 angleflow pump. This 8-in. pump stands 22 in. high and can handle 800 gpm.

The F-M angleflow pumps are designed for large volume at comparatively moderate heads and are used in drainage, irrigation, water supply, screened sewage and storm water service, dry dock and cofferdam dewatering, and many other services.

Oxygen Generator

Joy Mfg. Co. of Pittsburgh, Pa., announced the development of a semiportable oxygen generator that will enable industrial users to produce their own high purity oxygen at reported savings up to 50 per cent.

The generator is a compact unit requiring a space of 600 cu ft ($8 \times 7\frac{1}{2} \times 10$ ft). Simplicity is its keynote and it has a minimum of moving parts. The machine has no dependence on chemicals and nothing is consumed except air and power. Models are contemplated by Joy in the size range from 0.5 to 12 tons daily capacity of oxygen of 99.5% purity.

Despite the small size of the unit, it is reported that it can produce high purity oxygen at an operating cost of five to ten cents per 100 cu ft, depending on how much of the time it runs. This is equivalent to $12 to $24 per ton and, as compared to the cost of purchased oxygen, represents savings to users of from 60 to 85% before amortization. Savings to the consumer come mainly from eliminating oxygen transportation.

Heart of the Joy oxygen generator is a series of automatic reversing heat exchangers which eliminate the expense of chemical purification of the air and contribute to high efficiency.

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Ejector Mechanism

A panel mounting rack, incorporating a mechanism for rapid installation or ejection of control or amplifier panels, has been developed by the Aircraft Dept., Westinghouse Electric Corp., Lima, Ohio.

The mechanism has greatly reduced the time and effort required to engage the connectors, to hold the panel securely, and to lock it in position. The addition has added only 8 oz to the weight of the rack, for a total weight of $1^1/_2$ lb.

An operating handle, moving in a horizontal plane, operates a pin which projects through the bottom of the rack. As the handle is moved from an open to a closed position, the pin rises from a recessed position, engages with the panel, moves it towards the connector, and, at the end of the cycle, locks it securely with the connectors. Rotating the handle through an arc of less than 90 deg towards the open position effortlessly and quickly disconnects the panel from the rack.

The end of the panel opposite to the connectors is held securely by two powerful inclined springs. These springs engage inclined planes on the base of the panel. Adaptation of a panel requires only the provision of a hole for pin engagement and two inclined surfaces for spring clip engagement. The mechanism is adaptable to various sizes of racks.

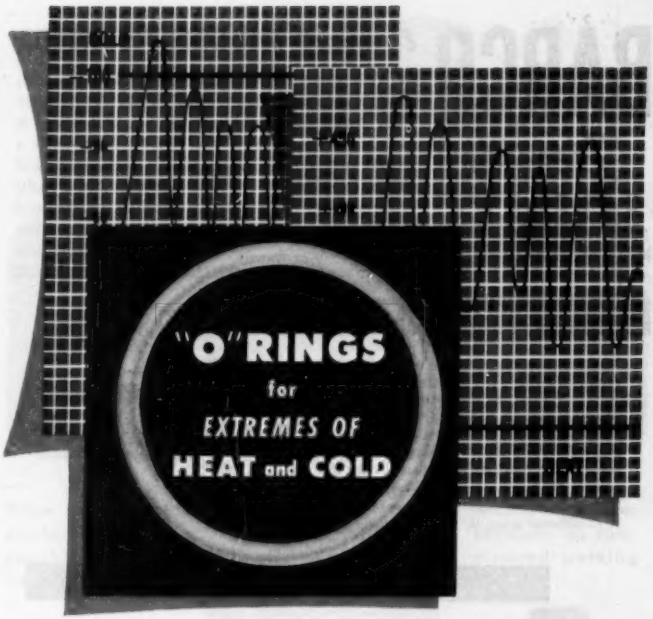
Vane-Type Pump Motor

A new 2000-psi vane-type oil hydraulic pump that can also be used as a fluid motor has just been announced by The Denison Engineering Co., Columbus, Ohio.

This new pump/motor is of single-stage design and reported to incorporate a new principle of radial balance and construction. No alterations of any kind are necessary, within the unit itself, to utilize its two-way performance. Used interchangeably it reduces inventory required where both types of units are regularly used.

In addition to these dual-purpose qualities, the unit permits either clockwise or counterclockwise rotation, for both pump and motor operation. Direction of rotation, in any type of application, can be reversed by means of a simple change in position of the pumping cartridge. The three major parts of these pumps are easily disassembled by removal of a few cap screws.

Four sizes are available, and each size is offered with a choice of cam rings, to widen the range of oil delivery or torque ratings. This provides a range of eight models of different capacity levels. In pump applications, these capacities range from $2^1/_2$ to 60 gpm maximums; in fluid motor use, capacities range from 12 to 257 in-lb of torque per 100 psi.



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Avoid premature seal failures by selecting the proper "O" Ring materials. For "O" Ring applications that encounter temperature extremes as low as −110°F or as high as +480°F, the use of silicone "O" Rings is indicated. Silicone "O" Rings also provide excellent resistance to chemicals . . . weathering . . . oxidation and moisture. If you have an application requiring "O" Rings to maintain a seal for long periods at either very low or high temperatures, it will pay you to investigate the many properties of silicone rubber. All dash numbers of 6227, 6230 and 6290 series for industrial applications or Army-Navy installations to Specifications MIL-P-5516 (6227 and 6230) and MIL-G-5510 (6290) are available from stock. Silastics and other special compounds are available on order.

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BARCO *Flexible* JOINTS *to meet* INDUSTRY'S NEEDS

● Wherever piping connections must move, look to BARCO for the ANSWER! Whatever your problem, Barco, invariably, can solve it BETTER, EASIER, and QUICKER with a tested and proven joint right out of the standard Barco line. This is because Barco builds a truly complete line of flexible ball, swivel, swing, and revolving joints—*there is a size and type for every purpose!* Submit your problem; ask for recommendations—Barco is at your service.

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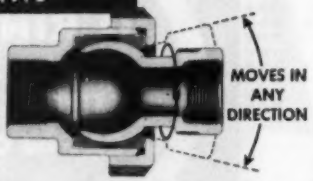
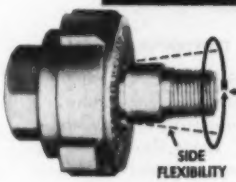
"One joint does the work of two or more!"—because it moves in any direction. Standard the world over where low cost, leakproof movable joints are needed in piping handling steam, air, water, oil, gas, or chemicals. Many models available. Up to 40° side flexibility *plus* 360° swivel action. Also used to facilitate quick connection of piping, overcome misalignment. Pressures to 7,500 psi; temperatures to 1,000° F. 15 different sizes, ¼" to 12". *Bulletin 215.*

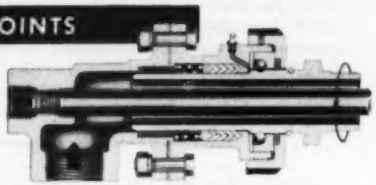


FLEXIBLE SWIVEL JOINTS



Exclusive angular motion prevents binding—only Barco offers this important advantage! Widely used for making compact, low torque swivel connections to reciprocating or rotating parts on platen presses, tire molds, oil burners. Easy to position piping accurately—no sagging, flopping lines. Leakproof, safe—pressure or vacuum. Ratings as high as 600°F., 3,000 psi (hydraulic). Sizes, ¾" to 2"; angle or straight. *Bulletin 265.*

REVOLVING JOINTS



Minimum roll "drag" cuts power costs—up to 50% savings! Note wide spacing between bearings; inherent low torque little affected by pressure, speed, or temperature. Parts easily accessible. Light running action minimizes wear, permits free-floating installation. No adjusting necessary—long, leakproof service. Ratings to 250 psi (steam); 450°F. Single flow or syphon styles. Sizes ½" to 3". Wide choice of models; speeds to as high as 2,500 RPM. *Bulletin 300.*

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For detailed information on Barco Joints, write for latest literature:

Bulletin 215: "Barco Ball Joints."
Bulletin 265: "Barco Swivel Joints."
Bulletin 300: "Barco Revolving Joints."
Bulletin: "Barco Swing Joints."

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Those having applications calling for a versatile 2000 psi pump or motor can secure complete specifications on this new unit by writing direct to The Denison Engineering Co., Columbus, Ohio, requesting a copy of Bulletin P-5.

Speed Reducer

A new double-reduction shaft-mounted speed reducer with capacity to 43 hp, and for output speeds from 12 to 110 rpm, has been announced by the Dodge Mfg. Corp., Mishawaka, Ind.

The new No. 7 reducer greatly increases the applications for Dodge Torque-Arm Speed Reducers. It has 59% greater horsepower capacity than the No. 6.

Like previously announced models the No. 7 is shaft-mounted and anchored with a torque-arm which fastens to any fixed object. A turnbuckle enables fast, easy adjustment of belt tension. Installation is simple and economical. There is no foundation to provide; no flexible couplings are needed.

The new No. 7 reducer brings the number of sizes in the Dodge Torque-Arm line to eleven—divided in two series, single and double reduction—with capacities from 1 hp to 43 hp, output speeds from 12 to 330 rpm. The new Dodge Tri-Matic Overload Release is applicable to the No. 7, as it is to all models in the Dodge Torque-Arm line.

Tramp Iron Removal

At the Meadow Lands, Pa., plant of the American Brake Shoe Co. an Eriez permanent magnetic drum is paying for itself by removing quantities of core wire and tramp iron from foundry sand. As part of the sand reconditioning system in this modern plant, the Eriez unit helps to purify a costly material, thus effecting considerable savings. The importance of this function is realized when it is understood that daily foundry production is directly related to the availability of clean sand.

The magnet installation consists of an 18-in-wide revolving cylindrical shell within which a stationary high-powered Alnico permanent (nonelectric) magnet is located. The magnet covers about half of the cross-sectional area of the drum.

Ferrous-contaminated sand is directed into the drum hopper wherein the rate of flow is

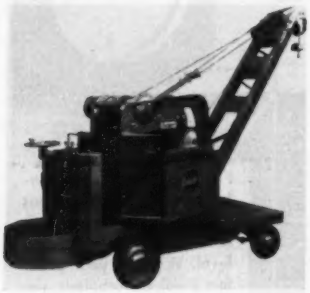
regulated. The sand then falls onto the revolving stainless-steel shell. The magnetic tramp iron adheres while the nonmagnetic sand falls off and out through a discharge chute. The iron sticks to the shell until rotated out of the magnetic field. It is then released and discharged into a separate chute.

Tramp iron separation by Eriez drums is a completely self-powered operation requiring no power and involving no operating costs. The units are recommended for the removal of tramp iron and medium fine ferrous contamination where materials are conveyed in spouts, chutes or similar conveying systems not employing belts. Such materials as grain, tobacco, plastics, ceramic sands, ball clays, crumb rubber, powders, chemicals, etc., are readily purified of iron contamination with Eriez drums.

The Eriez equipment is made by the Eriez Mfg. Co., Erie, Pa.

Mobile Crane Truck

A new line of mobile crane trucks, particularly adapted to handling heavy castings, machinery, bar stock, sheet-metal packs, and other irregular-shaped material in and out of flat, gondola, or box cars, has been announced by The Baker Industrial Truck Div. of the Baker-Raulang Co., 1230 W. 80 St., Cleveland, Ohio.



With their 19-ft telescoping booms, these units are a valuable tool for locomotive stripping in the repair shop, erection jobs, dock, warehouse, and general millwright work.

Combining travel, hoist, boom, and slew motions in one sturdy compact unit, they also supplement overhead crane equipment by working in areas not served by such equipment.

Capacities available are 6000 and 10,000 lb.

Fatigue Machine

A new model of the Baldwin-Sonntag SF-2 fatigue machine is announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. The SF-2 is a table model, the smallest of five standard models which now range in alternating force capacity from 25 to 10,000 lb or from 50 to 20,000 lb in one direction only. Maximum travel of the loading yoke is $\frac{1}{2}$ in. and testing speed is 1800 cpm.

Maximum load capacity was increased 25 per cent and redesign makes the machine similar to the next larger size fatigue machine, the SF-01-U. Simulated service tests of small parts can now be made on the new model machine whereas the original machine was limited to sheet-metal specimens.

EYE-HYE
Gage reading at eye-height any reasonable distance from drum
Easy to read, like conventional gage
Illuminated green fluid gives sharp clear indication
Simple, manometer principle, no complicated working parts
Easy to install, practically no maintenance
Models for all pressures, from 0 to 2000 pounds
Panel-mounted EYE-HYE
Wall-mounted EYE-HYE
Reliance EYE-HYE
Write for full data on EYE-HYE—tell us working pressure and control location
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The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio
Reliance EYE-HYE
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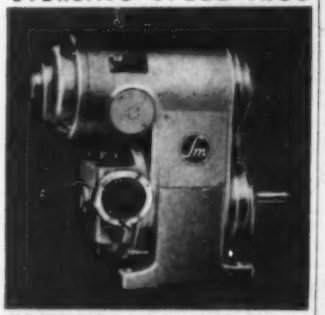
All-hydrostatic - Reads like a tubular glass gage

Best Answer To Conveyor Problems Found In Speed-Trol

Speed-Trols were the best engineering answer to our problems in conveyor installations for the Railway Express Agency at their St. Louis Terminal, reports Robert H. Mayer, Vice President, Alvey Conveyor Manufacturing Co. Speed-Trol's positive speed setting, wide speed range, fingertip speed control, ruggedness and compactness solved our problems of wide differences in load with respect to weight and quantity, space limitations, and the need for quick, easy speed adjustment.

STERLING SPEED-TROL



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70 ILLUSTRATIONS showing how Sterling Electric Power Drives reduce production costs. Write for Bulletin No. A 101

STERLING ELECTRIC MOTORS

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Offices and distributors in all principal cities

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Another feature is an accessory preload attachment which becomes a part of the machine when desired. This permits applying preload either in up or down direction. Any pulsating load may be superimposed on a static preload within the capacity of the machine.

The SF-2 is driven by a 1/4-hp synchronous motor, has a dial load indicator which is graduated in 0.125-lb increments, and a cycle counter. The new design provides a cage guided by flexure plates which absorb horizontal components of centrifugal force, and a tension-compression spring for inertia force compensation. Within the cage is an eccentrically mounted mass driven by the motor through flexible couplings. The mass is on the end of a micrometer screw by means of which the dynamic load is varied. A scale on the cage indicates the centrifugal force produced by the revolving mass.

Over-all dimensions of the SF-2 fatigue machine are 19 1/4 in. wide × 25 in. long × 21 3/4 in. high.

Improved Unit Pillow Block

An improved unit pillow block, with a lubricant-retaining DuPont Fairprene red seal, has been announced by SKF. Practically frictionless wiping action of the seal against the inner bearing ring is a feature of the new Hess-Bright "SY" unit.

Other features are rotating flingers to exclude dirt, a collar with set screws for easy installation, spherical outer ring compensation for initial misalignment, relubrication through Alemite fitting, and interchangeability with existing installations.

The "SY" pillow block was designed for use in conveying, agricultural, chemical, food, ginning, and textile machinery; light fans and blowers; light power take-off units and jack shafts, among others.

It eliminates costly machining, is quickly applied, factory-sealed against dirt contamination, requires infrequent lubrication and reduces maintenance costs. Shaft diameters range from 1 3/16 to 2 3/16 in. Available through SKF distributors, or SKF Industries, Inc., Philadelphia 32, Pa.

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Orifice Metering

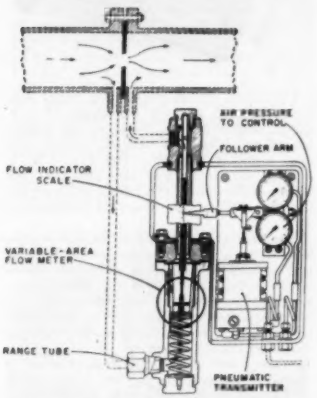
With a new product, known as the V/A Cell, the Fischer & Porter Co., Hatboro, Pa., introduces to industry an entirely new approach to orifice metering. Instead of measuring the static-pressure differential across the orifice (as do conventional mercury manometers) the new Fischer & Porter unit meters a continuous by-pass stream around that orifice.

Thus, the metering is kinetic—a constant flow continuously purges the lead lines.

Second, a linear relationship exists between the metered by-pass flow and the main flow past the orifice—avoiding the square-root relationship between manometer action and orifice flow which has so long plagued orifice metering. The linearity and the consequent ten to one rangeability is inherent in the new method.

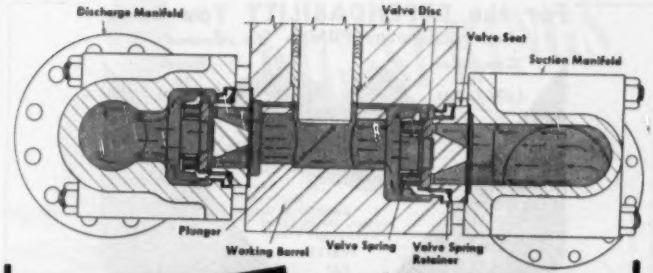
Third, the new method permits very simple adjustment of the by-pass rate, to give the unit enormous flexibility (usefulness over widely different flow ranges).

A fourth important attribute of the V/A Cell as applied to orifice metering is its adaptability to pneumatic connection to points remote from the orifice run.



The principal parts of the V/A Cell are: a variable-area meter whose float position inside a tapered tube changes with flow; a balanced follower arm, magnetically linked to the float; and a pneumatic unit for transmitting flow-rate measurement to remotely-located recorders, indicators, totalizers, ratio controllers or other receiving instruments.

In operation, the cell is connected across the orifice plate in line with usual orifice-metering procedures. It can handle pressure differentials up to 1400 in. of water column. The pressure differential causes a fraction of the flow to pass through the lead lines, range tube, and variable-area flow meter. The carefully balanced float, riding freely in its tapered tube, is supported at a height determined by the flow. The float, completely free of mechanical linkage and attachments, carries two small Alnico magnets which couple it to the yoke of the follower arm without the need for pressure seals, bearings, or bellows. The pneumatic transmitter translates the position of the arm into air pressure and sends this signal, linear with flow, to a receiver instrument.



Aldrich engineers eliminated two right-angle turns in the fluid-end. Now, liquid passes from suction to discharge manifold in a *straight line*. That gave the Direct Flow Pump its name, and set up a whole new concept of pumps, pumping, and pump maintenance. It all adds up as follows:

☐ **Increased operating speeds**—you get whatever volume and pressure you need *from a smaller, lighter, more compact pump.*

☐ **Sectionalized construction**—parts can be replaced at a fraction of the cost of a new fluid-end; also, parts can be made of stainless, bronze, Monel or other special materials—extremely important for corrosive fluid service.

☐ **Maintenance made easier**—no more tapered bores in the working barrel. Manifolds are *not* taken off but slide out on studs—affording room to *lift out* valves as complete units. Packing is easily renewed—note accessibility of stuffing boxes.

☐ **Interchangeable wearing parts**—available among 3, 5, 7 and 9 plunger pumps of same stroke size. This minimizes spare parts costs and inventories.

☐ **Changeable plunger sizes**—in many cases it is only necessary to add new plungers, glands, throat bushings and packing *to the same fluid-end.*

☐ **Drive direct**—by connection to synchronous engine type motor or internal combustion engine; also with integral speed reducer or V-belts.

Contact your Aldrich Representative . . . or write to us direct for complete details on 3″, 5″ or 6″ stroke units.

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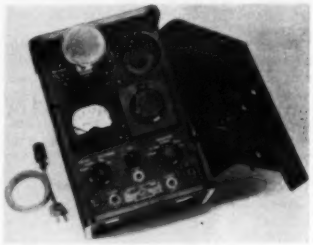
Sound-Level Meter

A new sound-level meter announced by General Radio Co., 275 Massachusetts Ave., Cambridge, Mass., measures product noise quickly and simply both in the design department and in production. It also is idea for studying noise levels in working areas involving worker safety, comfort, and efficiency. Other applications include psychoacoustic studies, measuring the performance of systems transmitting music and speech, and evaluating the characteristics of acoustic materials. Furthermore, the sound-level meter is the basic instrument of any comprehensive sound-measuring system where its usefulness can be extended by numerous accessories.



The Type 1551-A sound-level meter has been designed to take advantage of new tubes, components, and miniaturization techniques, resulting in a smaller, lighter, and more useful instrument. The Type 1551-A weighs only 11 lb, less than one half the weight of the older Type 759-B, and occupies less than 40% of the volume of its predecessor.

The very stable circuit of the new sound-level meter uses a two-stage preamplifier as well as a three-stage main amplifier. Overall frequency response of the amplifiers is flat from 20 cycles to 20 kilocycles so that full advantage can be taken of the new high-fidelity microphones. All of the instrument's characteristics conform to the ASA Specifications, and the direct measurement of sound pressure levels can be made over a range from 24 to 140 decibels, a power range of 400 billion to 1. Self-contained batteries power the instrument for portable operation, but a small a-c power supply is available when continuous use is contemplated.

The diaphragm-type Rochelle-salt crystal microphone is removable so that it can be placed at the end of a cable, or be replaced by another microphone with special characteristics. The output from the sound-level meter is available for operating such auxiliary equipment as frequency analyzers, level and tape recorders, and oscillographs.

G.E. To Build World's Fastest Cold Strip Steel Mill Drive

The world's fastest cold strip steel mill drive, designed to operate a five-stand tandem mill at a top speed of 79½ mph, is being built by the General Electric Co. for the Fairless Works of the United States Steel Co.

This 21,650-hp drive is part of an order for G-E equipment for the giant new Pennsylvania plant. It is believed to be the largest single order ever placed for steel mill electric apparatus.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

With a planned capacity of 1,800,000 ingot tons of steel a year, the Fairless Works will be the largest integrated steelmaking installation to be built in less than two years time. It is being constructed on a 3800-acre plot on the Delaware River near Morrisville, Pa.

Outstanding equipment for the vast plant will include not only the record-breaking cold strip mill drive, but also one of the world's fastest annealing lines (1000 fpm) and one of the largest annealing furnaces ever built—all supplied by General Electric.

The Fairless Works will have an annual capacity of 289,000 tons of cold-rolled sheets, 285,000 tons of bar products, 235,000 tons of hot-rolled sheets, and 170,000 tons of tin mill products.

Low-Lift Platform Truck

A new combination low-lift platform truck and crane has been announced by The Elwell-Parker Electric Co., 4205 St. Clair Ave., Cleveland 3, Ohio. It is designed to solve plant maintenance problems although it also can be used to advantage for handling production materials which do not lend themselves to more conventional handling techniques.

In addition to the standard 4000-lb capacity, self-loading platform designed to lift and transport skids, the truck is equipped with a powered winch for pulling heavy loads on or off the platform. The boom which swivels 180 deg, permits hoisting loads weighing up to 2000 lb. With this equipment, the truck is well suited for transporting maintenance material, machinery moving, motor or transformer placement, steam fitting, and general plant repair work. The truck can also be used for lifting, carrying, or positioning heavy odd-shaped loads such as castings, large assemblies, etc.

Power is supplied to the individual motors which power the drive, platform lift, winch, and hook by an electric storage battery or gas-electric unit. The winch, platform, and hook can be controlled from both the operator's position and the load end using the remote-control switch located on the boom. Two-wheel drive, four-wheel steer is provided. All motors drive through worm-gear reduction units. The platform lift operates on a three-link rocking-type mechanism protected from overloading with a safety link. Although the truck illustrated is equipped with a fixed boom height, models are also available with moveable booms.

Over-all length of the truck is 134 in.; width, 41 in.; height, 72 in. Maximum hook height is 57 in. with an outreach of 61 in. Platform height is $10^{7}/_{16}$ in. with a lift of $5^{3}/_{4}$ in. The platform measures $26^{1}/_{2}$ in. wide × 53 in. long.

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Keep Informed — New Equipment — Business Notes — Latest Catalogs

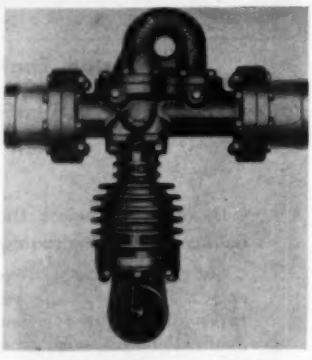
Ventilating and Exhaust Fan

A heavy-duty belt-driven fan for industrial applications, duct work, mine exhaust systems, and filtering units where large volume of air is required under static pressure is announced by Chelsea Fan & Blower Co., 639 South Ave., Plainfield, N. J. Being belt driven, this fan is quieter in operation than fans of similar capacity that are direct driven. It is equipped with nonoverloading cast aluminum airfoil type propellers. These units are completely ball bearing and motors are totally enclosed. Units available in sizes from 24 to 48 in. and air deliveries from 5000 to 28,000 cfm. These rugged, heavy-duty fans are more economical than centrifugal-type fans for similar applications. Write for Chelsea's new catalog No. 400 or Bulletin No. 404-A.

Air delivery ratings are determined by the standard test code of the Propeller Fan Manufacturers' Association and American Society of Heating and Ventilating Engineers.

Shuntflo Steam-Measuring Meter

Builders-Providence, Inc., Providence, R. I., has announced redesign of the Model SMKS Shuntflo meter for steam, air, or gas. This time-proved meter boasts the following improvements: (1) New, streamline damping chamber to facilitate a more uniform cooling system; (2) all Meehanite body casting for greater strength and durability;



(3) a more simplified rotor mechanism to assure greater efficiency of operation, easier replacement of parts and longer service; (4) Strengthened rotor shaft designed to withstand slugs of undue condensate in the line or sudden fluctuations in line pressure.

Builders-Shuntflo Meters are used widely by District Heating Companies and in Industry for departmental heating and process work. Write for further detailed information—Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.

Valve Packing

In order to short-circuit the electrolytic action that attacks 410 and 416 chrome-steel valve stems after a hydrostatic test, the new "John Crane" Style 187 Packing (Pat. Pending) was developed. This packing employs a special sacrificial metal which effectively side tracks electrolysis and the pitting action that otherwise would occur during the period between hydrostatic test and actual valve use.

Packing is braided of purest asbestos yarn around a resilient, graphite and asbestos core and is designed for use with steam valves on temperatures up to 850 F; pressures to 2000 psi. The new "John Crane" Style 187 Packing is impregnated throughout with antifrictional, dry graphite lubrication (which is far superior to mica) and requires minimum adjustment of the gland, with easy stem operation. The core contains no volatile or rubberized material that could harden in high-temperature service.

This packing can be die-formed in any size required to fit square or bevelled and stuffing boxes. Same corrosion-eliminating feature is also available in endless plastic rings style 172 RCR (small water and steam valves, 172 DCR (Hydrocarbon Valves) and Style 177 AICR (for steam service to 1200 F).

One of the nation's leading valve manufacturers has used the new packing for the last year and reports that it has proved to be the most satisfactory packing ever used. The name of this manufacturer will be sent on request by writing Crane Packing Co., Dept.—1800 Cuyler Ave., Chicago 13, Ill. Also, ask for full details about the new "John Crane" Style 187 Packing.

Improved Plastics

Dr. James H. Freeman, a scientist at the Westinghouse Electric Corporation's Research Laboratories, has found a new analytical method of determining the chemical composition of Bakelite-type plastics.

The "Blotter" technique—more precisely called paper chromatography—was first used

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by chemists 100 years ago. In the last decade it was revived and used in the study of proteins. Only within the last year, however, has the method been applied to the study of phenolic resins and plastics.

Everyday items made from these Bakelite-type plastics include: radio and television cabinets, electric light switches, telephones, electric fan blades, the handles on electric irons, and bearings for many machines. Dr. Freeman's new analytical tool will have particular application in the development of insulating resins and varnishes for Westinghouse equipment.

Here is how the paper chromatography technique is applied. A strip of white blotter-like paper is suspended in a large glass jar about two feet high. Pinpoint samples of known and unknown ingredients of a phenolic plastic are placed at intervals along the top of the paper. The top of the strip is held in a glass trough filled with a solvent capable of dissolving the samples. More of the solvent is kept in a small dish in the bottom of the jar to keep the air inside saturated.

In much the same way that a blotter corner draws ink from a spilled drop, the solvent begins to "run" down the paper and carries the ingredient samples with it. After 15 or 16 hours, the solvent "front," or its leading edge, has nearly reached the bottom of the paper which still appears white. However, when an "indicator" chemical is "painted" on the paper, different colored spots appear. Their position on the paper enables the scientist to identify them. The color of the spots serves as an additional check.

Dr. Freeman said the primary value of this method of analysis when applied to resin chemistry is that it provides a specific and highly sensitive technique by which given substances including some previously unknown ones may be separated and identified.

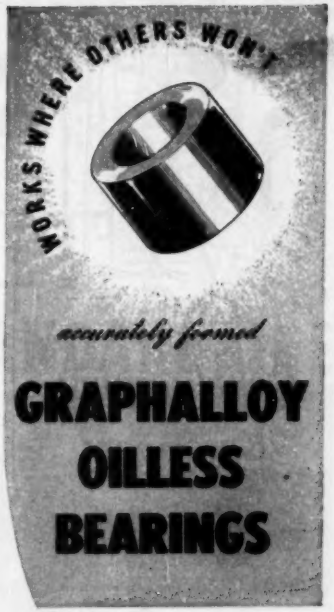
Underground Pipe Conduits

The Porter-Hayden Companies, Insulation Engineers and Contractors, 825 Frelinghuysen Ave., Newark 5, N. J., are now offering a so-called "U-Tile Type Conduit."

For general underground pipe work these companies usually recommend their larger "Therm-O-Tile" Conduit, which has been used for many years in connection with large central heating installations.

But, every once in a while they have found need for a conduit for one-pipe installations, or for installations having several small pipes. Hence the development of this U-Tile type conduit. This conduit system is in addition to the 27 different sizes of Therm-O-Tile underground conduit.

These U-Tiles are shipped to the job as "flattened cylinders," scored longitudinally on both of the flattened sides. Tapping over each scoring with a hammer splits the cylinders into two "U" tiles. A circumferential scoring at one end of each tile when chipped off provides a rough-edged bevel which permits the jointing mortar to key and bond into the channels formed within the tile sections. This makes possible strong, tight, flush joints, which can be effectively sealed with asphalt waterproofing mastic.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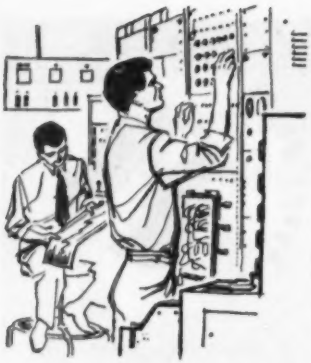

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If you are interested, please write giving a resume of your qualifications to Mr. Ross Wagner, Minneapolis-Honeywell Regulator Co., Dept. ME-1, Minneapolis 8, Minn. Your correspondence held in strict confidence, of course.

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Keep Informed

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

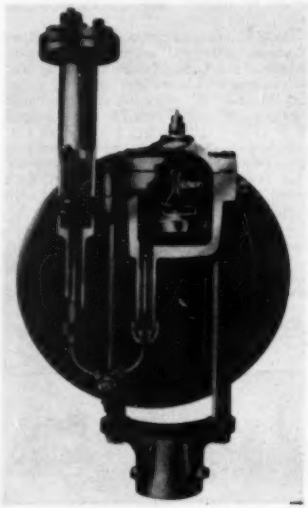
Recording Flowmeter

Higher sustained accuracy and easier maintenance are the results of five basic improvements in the design of Foxboro flowmeters.

Noted first is the pressure-seal bearing, lubricated at the factory to eliminate periodic lubrication maintenance. Leakproof at working pressures, the bearing uses no springs and needs no mechanical adjustments. The bearing body and its associated parts are interchangeable.

Also interchangeable are the plastic check floats which are kept clean by complete submersion in mercury. A new stainless-steel ball-plug and seat prevents clogging and locking.

The improved U-bend has metal-to-metal compression seals, tested at 10,000 psi for full protection against mercury loss. New, replaceable seats are made of hardened stainless steel. There are no gaskets to replace.



The new damping plug is calibrated to simplify damping adjustments. With the plug set at drain position, the drain port, located at the low point in the U-bend, allows mercury to be completely emptied without spillage.

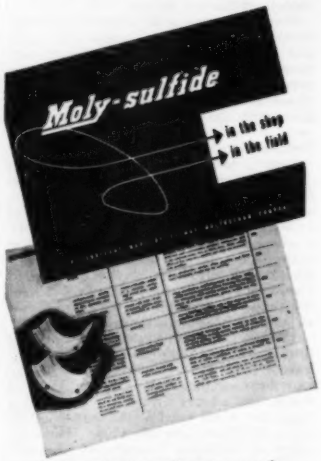
Finally, a new type of stainless-steel ball-chain, by which the powerful straight-line motion of the float is transmitted to the recording pen assembly, eliminates friction and errors of angularity.

Details of these advances, along with complete information on Foxboro meters and auxiliary equipment for the measurement or control of fluid flow of any kind are contained in the 36-page Bulletin 460, available on request from The Foxboro Co., Foxboro, Mass.

Improved Die Steel

Alhead, a recently introduced product of Allegheny Ludlum's Tool Steel Div., represents a completely new approach to the development of an improved die steel for cold heading dies.

154 ideas on ways to use...



154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own.

Moly-sulfide
A LITTLE DOES A LOT

The lubricant for extreme conditions

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Keep Informed — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

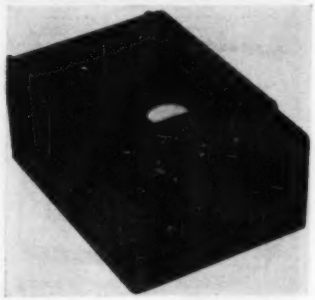
It makes available for the first time a higher alloy steel that can be water-hardened exactly the same as the straight-carbon or carbon-vanadium steels formerly used for cold-heading dies, but has much greater wear resistance and will produce many more parts in service. Repeated production runs on Alhead cold-heading dies indicate a die life of two to four times greater than steels available in the past.

The "Blue Sheet" on this grade gives certified laboratory data on analysis, proper methods of handling and shop treatment, and complete physical properties, etc., on Alhead Cold Heading Die Steel. Copies may be secured from Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.

High Gain Preamplifier

Now available for delivery is a new high gain a-c preamplifier, designed to permit the extension of the measurable range of graphic recording instruments or cathode-ray oscilloscope into the microvolt region and maintain a relatively flat frequency response from 0.2 to 400 cps.

Designated as Model BL-954 by the manufacturer, Brush Development Co., the instrument was designed for use with Brush magnetic direct writing oscillographs and medium or low-gain amplifiers to permit immediately available permanent records of measurements of electrical phenomena in the microvolt region such as brain, heart, and nerve potentials or research and industrial laboratory measurements.



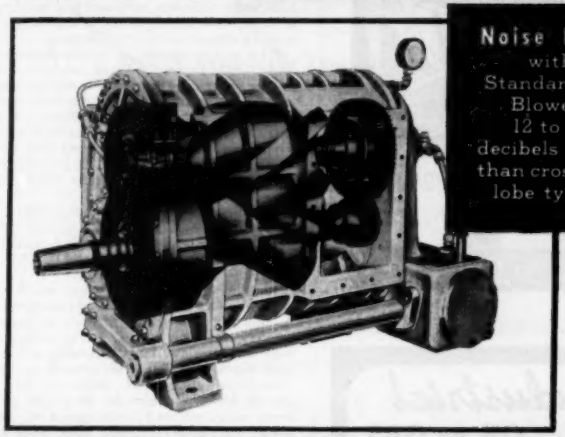
Voltage gain of the instrument is 200,000 times when operated push pull, and when used with Brush direct writing oscillographs and amplifiers is sufficient to give one millimeter of pen deflection on the oscillograph chart per 2.5 microvolts input. Noise and hum interference have been reduced by the use of a battery power supply. The dry "B" batteries are mounted in the carrying case while either external-storage or dry batteries may be used to furnish "A" power. A standard cell furnishes voltage for an internal calibration circuit.

The control panel includes a meter to indicate battery voltage, calibration push button, and gain control. The input jack is located on the front of case near carrying handle.

The preamplifier consists of three push-pull stages with balanced high impedance input and condenser coupled output.

A detailed description of this preamplifier may be obtained from the Brush Development Co., Instrument Div., 34, 3405 Perkins Ave., Cleveland 14, Ohio.

MUST BLOWERS BE LOUD OR QUIET Like a STANDARDAIRE



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Keep Informed

New Equipment | Business Notes | Latest Catalogs

Giant X-Ray

According to recent issue of Koppers Magazine, future models of military tanks for the Army Ordnance will move from the drawing board to the battlefront more quickly because the Corps of Engineers recently completed an electronic camera at the Eddystone Plant of the General Steel Castings Corp., near Philadelphia, Pa.

This apparatus, called a Betatron, can find a flaw in a steel casting as readily as a hospital x-ray machine can locate a break in a bone.

Actually the new $500,000 Betatron installation—one of the largest industrial Betatrons in the United States—is a giant x-ray machine which, because of its potent and deadly radiation, is housed in a building with walls six feet thick and is treated with as much respect as a bolt of lightning.

Prior to the installation of the Betatron, inspection of new welded tank turrets to determine where interior flaws would develop in quantity production often required more than two months. Now the process takes only a week and the x-ray pictures reveal even trivial flaws in the metal so clearly that new rules may have to be written to prevent the condemnation of all castings for minor imperfections.

The Betatron derives its name from its production of high energy beta rays or electrons, those minute particles with a negative electric charge which whirl around the core of an atom.

In many respects, operation of the Betatron resembles that of a two-coil transformer. A high voltage electric current is passed through a primary electric coil to energize a huge electromagnet. The secondary coil is a ring-shaped tube of glass known as the "doughnut." Electrons produced by a heated filament circle the doughnut at a speed which reaches 122,000 miles a sec (two thirds the velocity of light) after being accelerated by the electromagnetic field.

When these electrons reach their peak energy of 24 million electron volts, the magnetic field is reversed and the electrons break from their path around the glass doughnut and fly off against a platinum target. Bombardment of the target produces X-rays, which, in turn, are focused on the steel casting being inspected by the Betatron.

In less than a minute, the Betatron will take a complete x-ray picture of a welded steel component up to a 24-in.-thick casting. The Betatron is designed to find flaws in one eighth the time required by less powerful inspection devices.

Electronic Recorder

The new Olsen Model 51 Electronic Recorder incorporates the high-speed and accuracy inherent in the electronically controlled null balancing system which utilizes specially adapted atcotran differential transformers built into the housing. This null system rotates the recorder chart drum in direct proportion to the strain or deformation of the specimen under test. The testing machine produces a stress co-ordinate by horizontal movement of the nonclog pen of the recorder.

Sensitivity of this instrument is 0.05% of full scale for each range; accuracy of strain co-ordinate is $\pm^1/_8$ division (0.2% of full scale); accuracy of stress co-ordinate is equal to that of the testing machine. Standard instrumentation is available for motion detectors for magnifications ranging from 1000:1 to 1:1; magnifications are instantly available by flip of a switch, without gear change of any kind. Magnification may be changed without stopping test.

Dram rotation of the Model 51 Recorder is 10 in. in 4 sec for full scale. Curves are plotted on letter size ($8^1/_2 \times 11$-in.) cross-section paper, and the paper is held in place by a simplified clip.

Calibration of this instrument is based entirely on factory-sealed fixed linear distances. All component parts such as amplifier, motor, gear backlash, etc., have no effect on calibration.

This recorder may be applied to all types of testing machines for tension, compression and transverse testing. When used with beam and hydraulic gage types of machines an additional electronic null system is necessary to drive the load pen across the chart.

For complete information, address inquiries to Tinius Olsen Testing Machine Co., 1140 Easton Road, Willow Grove, Pa.

Oil-Tight Pushbuttons

A number of advanced design features are incorporated in a new line of oil-tight pushbutton units for machine-tool applications announced recently by the General Electric Company's Control Dept., Schenectady 5, N. Y.

The units, designed completely on the building-block principle, feature "self-a-line" contacts and removable color rings for pushbutton identification.

WANTED

MORE IRON AND STEEL SCRAP . . . OF ALL KINDS!

Steel mills and foundries need more scrap.

Not just "production" scrap from metal-fabricating plants . . . but also all sorts of *idle* iron and steel—from all types of plants.

Search *your* plant for this idle metal . . . work with your local scrap dealer to increase supplies of badly-needed iron and steel scrap.

What to look for . . .

obsolete machines, tools and equipment, no-longer-used jigs and fixtures, worn-out or broken chains, wheels, pulleys, gears, pipe, tanks, drums and abandoned metal structures. Non-ferrous is needed, too!

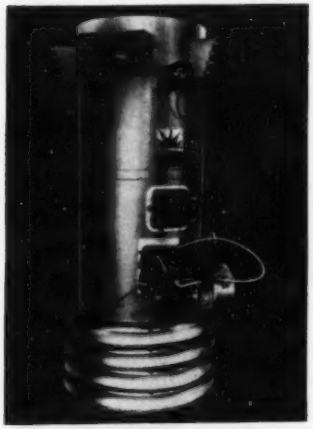
The building-block construction provides increased flexibility of application because the basic units can be arranged in various combinations to meet all special as well as standard requirements. For example two operators, five color rings, and two contact blocks can be arranged in any of 20 different combinations.

Also, inventory simplification is made possible by this assembly, and it is estimated that use of the new G-E units could reduce stock necessary to take care of special push-button needs to less than one sixth of that demanded by older systems.

Thermobloc Burner

A new combination oil-gas burner that will alleviate fuel shortages has been announced by the Thermobloc Div. of the Prat-Daniel Corp., South Norwalk, Conn. The burner is available for the complete line of Thermobloc industrial-type forced warm air direct-fired heaters.

The combination burner permits instantaneous change-over from gas to oil or oil to gas. There are no piping changes or burner changes needed. The change-over may be automatic or with manual pushbutton. While shortages of natural gas occur when the thermometer plunges downward, and fuel oil may occasionally be in tight supply, it is unusual for both fuels to be scarce in any single district at the same time.



In effect, the burner always operates for the greater part of the heating season on the most economical fuel available. The change-over occurs during the cold snaps that place a drain on supplies.

The combination burners have been extensively installed in the Kansas City, St. Louis, and Ohio territories with users enjoying the "dump load" rate. Limited gas supplies in these areas have meant that no new straight gas heating loads could be imposed on the line. Gas companies permit this type of installation, however, because they can shut off supplies at any time, without imposing a hardship on the user.

The burner may be changed from gas to oil or vice versa manually, by a flick of the switch. All that is needed for completely automatic operation is an outdoor thermostat which can be adjusted to a change-over thermometer.

HOW TO KEEP CLEAR OF ERASURE "GHOSTS"

Specify Arkwright Tracing Cloth, and you'll get clean, clear, "ghost-free" blueprints no matter how often you erase the drawing.

You can re-ink razor-sharp lines on Arkwright cloth without "feathering" or "blobbing". More important, you can be sure that drawings will never become brittle, opaque or paper-frayed with age.

They're good reasons for you to remember: if your work is worth saving, put it on Arkwright Tracing Cloth. Want a sample? Write Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

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The Proven Gear-Type Coupling With Fully Crowned Teeth . . . A Major Improvement in Gearing. This proven gear-type coupling with fully crowned teeth is being utilized in solving a wide range of power transmission problems other than those common to ordinary gear-type couplings
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THIS FUNDAMENTAL IMPROVEMENT in gear tooth design practically eliminates all "end tooth and tip" contact and provides greater freedom of axial movement. This tooth design accomplishes tight fit on the crown as well as on the flanks. It is the first gear tooth on which all the load is carried on strong flanks rather than tooth edges. It reduces backlash to a minimum. These advantages, plus thrust compensation, and correction for angular and lateral misalignments give maximum relief from coupling failure grief.

Amerigear Couplings, made in several standard types, are available for standard shaft sizes and a wide range of speed and load capacities. Catalog of standard type Amerigear Couplings is available on request. Amerigear Power Transmission Engineers are available for consultation.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Impulse Generator

New low cost Electro Magnetic Pick-up operates without physical contact when mounted near any moving magnetic material. The Electro Magnetic Pick-up is an electrical impulse generating device that produces a voltage output proportional to the rate of motion or speed of the magnetic object. It may be actuated by the keyway in a shaft, the teeth of a gear, the spokes of a wheel, a slot in the rim of a wheel or shaft, a screw head or pin on a moving part—or any vibration or displacement of magnetic material in the field of the Pick-up.

For measuring acceleration and velocity; triggering or synchronizing cathode ray oscillograph sweep circuits; angular position indicator (shaft or fly-wheel); reference marker (degrees, position). It will indicate rpm, count operations, sequences, cycles, or motion at rates in excess of 20,000 per sec. when used with electronic counters.

Manufactured by Electro Products Laboratories, Inc., 4501 North Ravenswood Avenue, Chicago 40, Ill.

Hand Calculator

The "Curta" Calculator, a new portable calculator fulfills a long-felt need of men who work with figures or formulas. Precision-made by Swiss watchmakers, the "Curta" calculator will add, subtract, multiply, divide, figure square roots, factors, cubes, and percentages, and is as easy to operate as a slide rule. Amazingly accurate, the new device carries to five decimal places and totals to 99 billion. Figures can be checked and re-checked on 3 sets of dials.

Although it weighs only 8 oz, it is claimed that the "Curta" will do as much as electric desk calculators costing up to $800. The price of the "Curta" device is $129 which includes a rubber-lined metal case. Complete information is available from the Curta Calculator Co., 5543 South Ashland Ave., Chicago, Ill.

For Consulting Engineers
Turn to Page 148

Keep Informed

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Stair Climber Magnesium Hand Truck

Manufacture of a new hand truck, equipped with stair climbers, has been announced by Magline, Inc. Fabricated completely of magnesium, the new model weighs only 16 lb, yet has an officially-rated load capacity of 450 lb. In addition to removable stair climbers, the new model 12-A-800-SC offers many engineering advances.

The use of mechanically joined, standard parts and assemblies provides for inexpensive parts replacement and truck repairs, the company states. This feature, which is now found on all the company's hand trucks, contributes to longer service life and lower maintenance costs. In keeping with these characteristics, the stair climbers have been designed as standard, interchangeable units, easily replaced when required, at moderate cost.

According to the manufacturer, engineered weight distribution, in combination with aircraft-type frame construction, represents another design advancement. Greater ease of operation under full load is achieved, as well as better balance. In addition, considerably less physical effort is required on the part of the operator.

For additional information and latest bulletin, write to Magline, Inc., Pinconning, Mich.

Business Notes

F. W. Stewart Opens New Plant

The F. W. Stewart Mfg. Corp., Chicago, Ill., announces the opening of their new Los Angeles plant at 1638 South Flower St. which gives them additional manufacturing space over their previous location at 431 Venice Boulevard. This new location will be devoted entirely to the manufacture and fabrication of flexible shaft assemblies, flexible shafting, and their components.

Alcoa Plans Fabricating Expansion

Plans for the expansion of Aluminum Company of America's fabricating facilities in the Pacific Northwest were announced recently. A definite schedule for construction has not been set.

Immediate plans, which have been in the making for some time, call for extensive modernization and revision of the ingot casting facilities at Alcoa's Vancouver (Wash.) Works. This would mean increased production of commercial notch-bar ingots and rolling ingots as well as the production of extrusion, forging, and other types of fabricating ingots for use by Alcoa's own operations and for sale to fabricating customers. Cost of the immediate expansion will be $1,217,500.

The current expansion by Alcoa is a forerunner of a projected plan to extend and diversify the fabrication of primary aluminum at Vancouver. As a part of an integrated expansion program for Vancouver, Alcoa plans to install hydraulic extrusion presses and specialized wire-working equipment some time in the future. The company also contemplates a modification of its existing rod rolling mill.

Protection
night and day

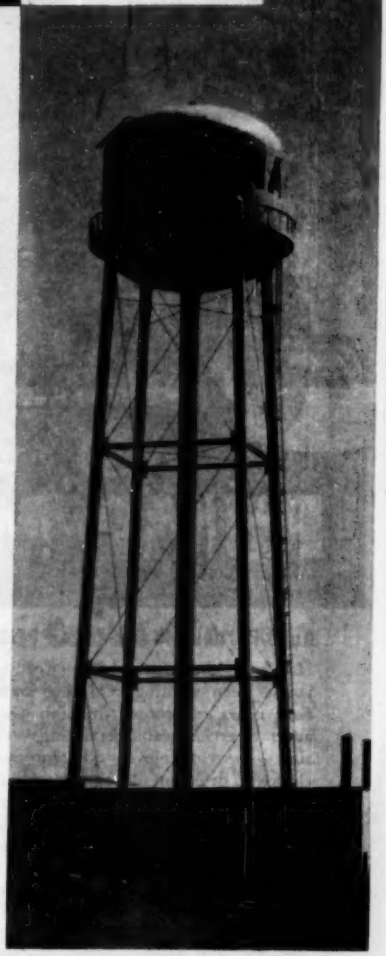
Dependable Water Supply at Mall Tool with HORTON TANK

Night and day fire protection in your plant calls for a dependable water supply—one that will stop fires while they are small—before serious property damage can occur.

A Horton elevated water tank, such as shown at the right, is always on guard, ready with a dependable flow of water to quench flames before they get out of hand. At the turn of a valve—or the opening of a sprinkler head—a steady stream of water can be brought to bear on the heart of the fire.

Horton ellipsoidal-bottom tanks are built in standard capacities from 15,000 to 500,000 gallons; Waterspheres from 25,000 to 250,000 gallons; and radial-cone tanks from 500,000 to 3,000,000 gallons. Write today for complete information.

Right: This 100,000-gallon Horton ellipsoidal - bottom water tank, 100 ft. to bottom is located at one of Mall Tool Company's plants in the Chicago area. It supplies gravity water pressure for fire protection.



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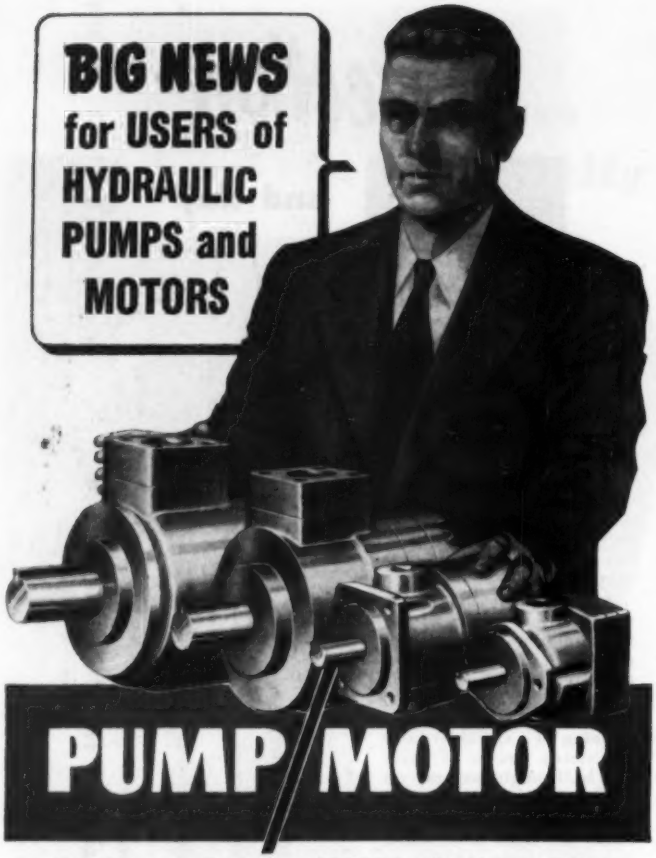
New York 6.....2901—165 Broadway Building
Philadelphia 3..1618—1700 Walnut Street Building
San Francisco 4.....1556—200 Bush Street
Seattle 1.....1321 Henry Building
Tulsa 3.....1610 Hunt Building
Washington 6, D. C.....1143 Colitz Building

Plants in: BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, Pa.



Dual-Purpose, Vane-Type POWER for Continuous Duty

Here's the kind of rugged, low-cost, long-service hydraulic power you've been wanting! Offering complete hydraulic balance of *both vanes and rotors,* this unit assures a dependable performance. Interchangeable cam rings — available for each of four sizes — provide eleven different models. Adaptable for either clockwise or counter-clockwise operation. Denison Pump/Motors are ready for use as either pumps or motors without alterations of any kind . . . built for hard, continuous duty at pressures up to 2000 psi. Pumping capacities range from 2½ to 70 gpm. Torque ratings for motor applications range from 13 to 257 inch-pounds per 100 psi. Wide variety of combinations possible for any porting requirement. Choice of mounting arrangements including CIMTC standards. Get full details on Denison Pump/Motors; write today for Bulletin P-5!

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DENISON HydrOILics

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Cleaver-Brooks Appoints Representative

The Cleaver-Brooks Co., Milwaukee, Wis., announces the appointment of the Dyke & Tutsch Co. of Milwaukee as a manufacturer's representative for the sale of Cleaver-Brooks boiler equipment. Dyke & Tutsch will handle a territory that includes nine counties in southeastern Wisconsin including Milwaukee, Racine, Kenosha, and Waukesha counties.

Hydropress Moves Offices

The offices of Hydropress, Inc., 570 Lexington Ave., New York 22, N. Y., and its Rolling Mill Division, 139 East 56th St., will be moved to the Empire State Building, 350 Fifth Ave., New York 1, this month. The Loewy Construction Co., Inc., a wholly owned subsidiary of Hydropress, Inc., now at 216 East 49th St., New York 17, will move to the same address.

Chain Belt Occupies New Administration Building

Chain Belt Co. is now occupying its new administration building, located at 4701 W. Greenfield Ave., Milwaukee, Wis. The new building, of brick, stainless steel, and glass construction, is directly adjacent to its Milwaukee manufacturing facilities, and houses the offices and departments of General Administration, Field Sales Administration, Sales Promotion and Advertising, Purchasing, Accounting, Statistical, Tax, Cost and Castings Sales.

Nice Ball Bearing Co. Commemorates 50th Anniversary

The year 1952 marks the Golden Anniversary of Nice Ball Bearing Company. Founded in 1902 by William Nice, Jr., and originally known as Pressed Steel Mfg. Co., Nice Ball Bearing Co. is now one of the oldest bearing manufacturers in the United States.

During the early years, the company pioneered in the development of ball bearings for use in automotive king pin and clutch applications, and during the first World War, made substantial contributions to the War Effort, specializing in the production of thrust bearings for military trucks and mobile gun mount bearings of several types. After the War, the company continued in the production, promotion, and sale of automotive king pin and clutch release bearings which were manufactured by special methods and machines designed and developed by Nice engineers. These new developments established Nice in the automotive field as an important source for bearings for both original equipment and replacement purposes. However, the Company sought to also expand the scope of its production and made large quantities of bearings for many diversified industrial applications.

During World War II, Nice Ball Bearing Co. produced many millions of bearings for military and essential civilian requirements, specializing primarily in the production of control pulley and airframe bearings for military aircraft. Large quantities of other bearings for use in ships, guns, military vehicles and machines were also produced.

Since World War II, the company has continued its policy and program of expansion and diversification so that now well over a million ball bearings are produced each month and are used in products all over the world.

Keep Informed

NEW EQUIPMENT
BUSINESS NOTES
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Illinois Gear Buys Land For Expansion

The Illinois Gear & Machine Co., 2108 North Natchez Ave., Chicago, Ill., has purchased approximately 200,000 sq ft of additional land, adjacent to their main office and works. The land is situated on the main line of the C. M. & St. P. Railroad, and is served by two sidings. An existing building on the property will be occupied by a pattern shop and pattern storage. The balance of the land will be improved to expand the company's machine shops, heat-treating, and parking facilities.

Anchor Coupling Opens Branch Office

The Anchor Coupling Co. Inc., of Libertyville, Ill., manufacturers of a complete line of low, medium, and high-pressure couplings and flexible hose assemblies, opened a new branch office and warehouse March 1 at 2100 Irving Boulevard, Dallas, Texas. The warehouse will be completely stocked to serve promptly the hydraulic hose needs of the oilfield industry.

Carboloy Permanent Magnet Plant To Be Built

Construction of a 90,000 sq ft permanent magnet manufacturing plant costing, with equipment, over $3,500,000 is under way in Edmore, Mich., it was announced by Carboloy Dept., General Electric Co.

The plant will represent a substantial increase over current manufacturing facilities for Carboloy Department's Alnico permanent magnets. These are currently being produced in Schenectady, N. Y., and are extensively used in all kinds of military and civilian equipment, including radar, radio and television receivers.

The new plant will house complete manufacturing facilities and will provide room for future expansion and new processing operations. It is expected that construction will be completed in the Spring of 1953. Initial employment, upon completion will be approximately 150 to 200.

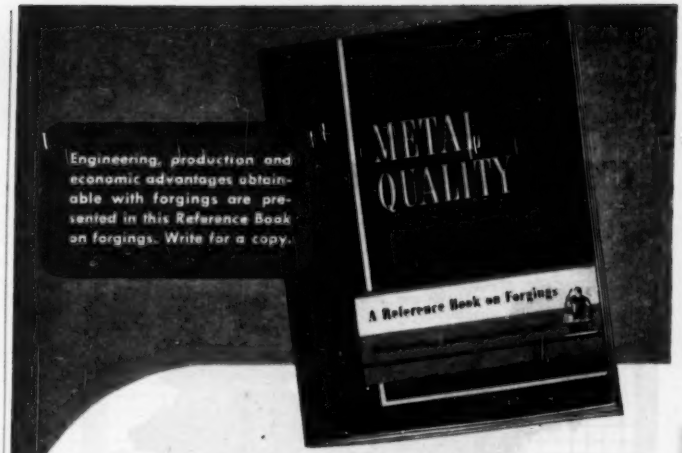
Permanent magnet marketing and engineering headquarters and facilities will be transferred from Schenectady to the Carboloy Department's main office in Detroit Mich.

Consolidated Engineering Purchases 35-Acre Tract

Future expansion of one of the most important industries in the Foothills area was indicated by the purchase of the Monrovia Airport, a 35-acre tract of land adjoining the Southeast section of the city of Monrovia, it was announced by Consolidated Engineering Corp. of Pasadena, Calif.

The tremendous growth and development of the electronics industry, in which Consolidated specializes, has made it necessary to secure property which will be adequate for future plans. In addition to space for plant requirements, employee living conditions were emphasized in the decision to secure the Monrovia property. The acquisition and development of this property will make it possible to provide some of the finest living and working conditions in Southern California.

Plans for improvement of the new CEC property are indefinite but the functions of the airport are expected to be discontinued as soon as possible after conclusion of escrow.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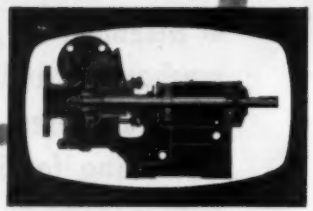
Goulds "SUPPORT-HEAD" CENTRIFUGAL PUMP

GOULDS Fig. 3750
Ball bearing support head type pump for direct drive or belt drive. Interchangeability of parts means reduced inventories.



Here's a pump that's ready to go to work, handling any one of a dozen jobs . . . Goulds "Support-Head" Centrifugal Fig. 3750. For example, you can use it for general industrial pumping, booster service, water supply systems, liquid circulation, and air conditioning service.

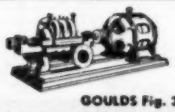
It is giving hundreds of plants in a variety of industries, long trouble-free service. Its extra heavy, well proportioned construction minimizes pump maintenance. Full open-top design provides ready access to gland and stuffing box . . . a particularly important feature in inaccessible locations. Goulds "Support-Head" Centrifugal pumps are available with capacities up to 3800 G.P.M. Heads up to 400 ft.

Full details in Bulletin 715.1. Ask for your copy today.

Other Sturdy GOULDS for Industrial Service

GOULDS Fig. 3450
These double-suction, single-stage centrifugal pumps will handle up to 15,000 G.P.M. Heads up to 500 ft. Bulletin 721.2.

GOULDS Fig. 3705
Stainless steel pumps for handling acid and alkaline liquors. Capacities up to 600 G.P.M. Heads up to 160 ft. Bulletin 725.3.



GOULDS Fig. 3330
Multi-stage centrifugal pumps for boiler feed and pressure service. Capacities 40 to 2000 G.P.M. Heads to 850 ft. Bulletin 722.1.

MEMBER

Goulds PUMPS INC.
Seneca Falls
New York

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Irving Subway Grating Co. to Operate at Peak Production

Barring interruptions in the steel supply, the Irving Subway Grating Co., Long Island City, N. Y., will produce open steel flooring at peak plant capacity throughout 1952. The company, observing the golden anniversary of its founding, should record its best output since 1945 in meeting demands for power plant, atomic plant, and factory expansion programs.

Fulton Sylphon Div. Acquires Company

The Fulton Sylphon Div. of the Robertshaw-Fulton Controls Co., Knoxville, Tenn., announces the acquisition of all manufacturing, sales, and patent rights in the seal developments of Renniks Co. and Ralph L. Skinner, Sr. of Detroit, Mich., and transfer of operations to its Knoxville plant. Ralph L. Skinner, Sr. will continue to actively participate in the seal program as a consultant on design and applications problems. New sealing elements, capable of withstanding high temperatures and pressures, have been developed utilizing the latest metals and plastics, such as Inconel X and Teflon. While activities have been devoted largely to defense projects, such as reciprocating and jet engines, fuel lines and injection nozzles, fuel and hydraulic fluid pumps, high-pressure steam systems, and other related applications, acquisition by Robertshaw-Fulton now makes them available to general industry.

New Westinghouse Plant Designed for the Future

Manufacturing executives of Westinghouse Electric Corp. agreed on a 60 × 40-ft column spacing for their new $1,500,000 television-radio plant at Metuchen, N. J. during preliminary discussions with the engineers responsible for its design and construction because that not only suited the immediate need for production of television receivers but also provided flexibility for the future.

Little did they realize that even before the building was completed or the television production lines installed, all plans would have to be modified so that classified electronic equipment could be produced for the armed services. Now, with the 420,000-sq ft plant getting into production, the wisdom of the preliminary decision can be seen. Wide bay spacing, with only ten interior columns per acre of floor space, has made the layout easy for production of equipment that was not anticipated.

Typical of some 20 flat-roofed industrial plants aggregating 7,000,000-sq ft in which The Austin Co. has used this cross section, the new Westinghouse plant is an outstanding example of Austin's "convertible building design."

Located well back from the highway (New Jersey Route 27) on a 55-acre tract bordering the Pennsylvania Railroad main line, the plant has an over-all length of 986 ft and a maximum width of 475 ft.

Provision for future expansion has been made by use of cinder block instead of brick in the rear wall. Steel sash has been used sparingly throughout the flat-roofed plant, which is lighted entirely by fluorescent fixtures and relies entirely on mechanical ventilation. Two fire walls, extending the full length of the building, divide it into three zones.

Dresser Absorbs Roots-Connersvil'e

Effective March 31, 1952, Roots-Connersville Blower Corp. of Connersville, Ind., was absorbed into the corporate structure of its parent, Dresser Industries, Inc., and will now operate under the name, "Roots-Connersville Blower," a Division of Dresser Industries, Inc.

Roots-Connersville will continue to operate as a separate, completely integrated organization at the same address, with identical plant and management as heretofore. No changes in organization or plant facilities as a result of this action are contemplated.

Hagan Research Laboratory Nears Completion

Development and testing of combustion and process control systems and instruments will be a major function of the new research and development laboratory nearing completion at Hagan Corporation's Orrville, Ohio, plant.

Apparatus for frequency-response testing of all kinds of components of control systems and instruments will be perfected there.

Control systems will be developed "such as those being designed and built for installation at the Trenton Naval Laboratories, the U. S. Steel Corporation's Fairless Works, and the U. S. Air Force's Arnold Engineering Development Center at Tullahoma, Tenn.

Latest Catalogs

Arc-Welding Accessories

A new two-color, four-page bulletin on arc-welding accessories is available from the General Electric Co., Schenectady 5, N. Y. The illustrated bulletin, GEC-864, covers more than a dozen holders, ground clamps and connectors, and describes the uses, operation, and specifications of each.

Boric Acid Power Fuses

A six-page illustrated booklet, B-5469, titled "Boric Acid Power Fuses" is available from the Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. The complete line of power fuses for compact and economical short-circuit protection is described. Divided into three sections, the booklet discusses the type BA De-Ion® boric acid fuse, the type DBA drop-out fuse, and the type BAL current-limiting fuse. Ratings, construction, operating characteristics, and applications are presented for each type. References to complete literature on each type are included.

Corrosion

A Theory of the Mechanism of Rusting of Low Alloy Steel in the Atmosphere—38 pages with 20 tables, graphs, and photographs. Results from exposure tests on 71 low-alloy structural steels exposed in industrial and marine atmospheres lead to new theory of the mechanism of rusting, which satisfactorily accounts for the improved corrosion resistance secured by the addition of nickel to steel. Available from International Nickel, Dept. EZ, New York 5, N. Y.

Drilling Cast Iron

Comprehensive data on "How to Drill Cast Iron with Carbide Tipped Twist Drills" have been made available by the Carboloy Dept. of General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich. Included are detailed instructions on how to drill cast iron with such drills, as well as reports covering recent results in working with carbide twist drills in cast iron.

Water Gages and Water Columns

Available from Diamond Power Specialty Corp., Lancaster, Ohio., is a new bulletin, No. 1051, covering Diamond Bi-Color and clear glass water gages, water columns, and high-low water alarms. Bi-Color gage always shows steam red and water green. New flange connected gages, new sectional gage glass, new forged-steel gage valves, and new "Hi-Lite" illuminator are included.

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designers and draftsmen for

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Long-range development program involving small gas turbines and their application to mobile equipment.

- Development Engineer
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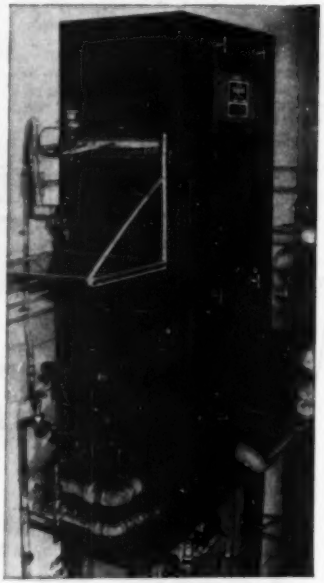
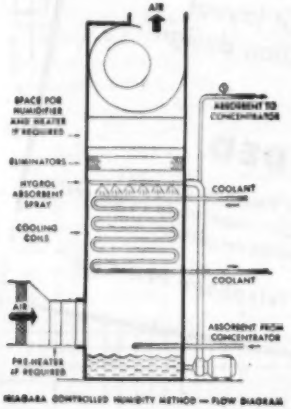
New "Controlled Humidity" Method Gives a Better Solution to Air Conditioning Problems

"Hygrol" Absorbent Liquid Dehumidifies Fresh Air Without Refrigeration



NIAGARA Air Conditioners or Dehumidifiers using "Hygrol" liquid absorbent give precise control of air temperature and humidity...at lower operating cost, with large savings in space and with smaller and less expensive equipment, in many applications.

This method dehumidifies the air by passing it through a chamber in which "Hygrol" spray removes its moisture and produces a low dew point. The "Hygrol" solution resulting is continuously and automatically re-concentrated, providing always full capacity in air conditioning and assuring always a constant dehumidifying capacity and a trustworthy, constant condition for your material, apparatus, process or room to be conditioned.



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Investigate this new Niagara Method for "comfort" air conditioning as well as to protect quality in hygroscopic material, or processes or instruments, or to prevent condensation damage to metals, parts or products.

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BUSINESS NOTES
LATEST CATALOGS

Permanent Magnets

A complete listing of stocked sizes and shapes of Carboloy Alnico permanent magnets is included in bulletin PM-100 available from Carboloy Dept. of General Electric Co., Detroit 32, Mich. The 20-page, $8\frac{1}{2} \times 11$-in. illustrated catalog contains pull curve and size information in tabular form on stocked types of Alnico permanent magnets, both cast and sintered, as well as size and application data on stocked holding assemblies, including sheet steel separators, magnetic retrievers, and magnetic stands. A list of available patterns for various sizes of cast Alnico bars, blocks, rods, rings and sleeves is included. The catalog also describes three types of Carboloy permanent magnet magnetizers. Tables of properties and tolerances in addition to ordering information and conversion tables are included to aid in applying and purchasing Alnico permanent magnets from stock.

Water Conditioning

A new 20-page bulletin, No. 611, covers the various methods of conditioning water and the purposes served by each. Features an improved water softener of "double-check" design which gives up to 44% greater capacity and guards against costly loss of zeolite. Tells how to make any water softener deliver from three to ten times more soft water. Describes a deionizer of single-tank design which produces ultra-demineralized water at a fraction of distillation or evaporation cost. Chemical feed, zeolite—post treatment, zeolite—alkalinity neutralization, and split-stream dealkalization systems for boiler, process, and general water-conditioning purposes are covered. Sections of the bulletin are devoted to latest type filters, purifiers, degasitors, zeolites, ion exchange resins, and water treatments for all purposes. Copy of booklet will be sent on request by Elgin Softener Corp., Elgin, Ill.

Centrifugal Pump Filmstrips

Now available through Allis-Chalmers general machinery division district offices is the first in a series of a new educational service to industry in the form of three 35-mm sound filmstrips on centrifugal pumps for showing before interested groups. Titles of the three films, each with a running time of about 30 min, are "How and Why of Centrifugal Pumps," "Pump Maintenance," and "Covering All Angles." This latter describes the selection of a pump and gives information required to figure its installation.

The film "How and Why of Centrifugal Pumps" shows parts and nomenclature, theory of operation, measurement of characteristics, and interpretation of curves.

The "Pump Maintenance" film illustrates how to set up a centrifugal pump, starting procedure, lubrication, packing maintenance, mechanical seals, piping tips, and the keeping of operating records.

Requests for showings of any of these filmstrips should be made to the nearest Allis-Chalmers general machinery division district office.

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Heliarc Torches

A convenient, pocket-sized folder containing operating data for Heliarc torches has just been released by Linde Air Products Co. Current ranges and electrode sizes for the standard tungsten and the 2% thoriated tungsten electrodes are listed in tables. A third table covers the current and number of passes required to weld various metals. Also included are suggestions for conserving tungsten electrodes, of particular importance with tungsten in such short supply. This folder may be obtained from any Linde office or direct from Linde Air Products Co., a Division of Union Carbide and Carbon Corp., 30 E. 42 St., New York 17, N. Y.

Instrument Transformer Buyer's Guide

The 1952 edition of the Instrument Transformer Buyer's Guide, containing basic, up-to-date information on the complete line of General Electric instrument transformers, has just been released by the company's Meter and Instrument Dept. The fully illustrated, 94-page publication, GEA-4626E, gives ratings, ASA accuracy classifications, and prices of all G-E indoor and outdoor potential and current transformers, metering outfits and potential and current portable transformers. Listings of ratio and phase-angle tests, together with tables covering the mechanical and thermal limits of current transformers, are also included. Available from the General Electric Co., Schenectady 5, N.Y.

Synchronous Motors

"Application of Direct-Connected Synchronous Motors to Reciprocating Compressors," is a reprint of a paper presented at the New York Section of AIEE, Power & Industrial Division, Motor Selection and Application Course in December, 1951. Written by G. L. Oscarson, chief application engineer, Electric Machinery Mfg. Co., this discussion deals largely with consideration of proper rotor flywheel effect (WK^2) as a preventive measure for voltage fluctuations when driving reciprocating compressors with direct-connected synchronous motors. Examples complete with formulas, sample calculations, and reference curves are included in this booklet. This 12-page technical article, No. 1200-TEC-1111, is available on request from Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Preventive Maintenance

A 28-page booklet published by Westinghouse gives a complete outline of the successful institution of preventive maintenance program for any industry. The booklet discusses general preventive maintenance programs, designed to reduce shut-down time on production lines, and treats in considerable detail the most important ingredients of production line apparatus—power equipment. A suggested schedule of work and cleaning on power equipment is presented in chart form, and the reader is referred from the chart to the general body of the booklet for more specific information. This general body contains all the essential information on the preventive maintenance for turbines, generators, switchboards, motors, controls, and many other types of electrical apparatus.

For a copy of this booklet, No. B-5477, write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

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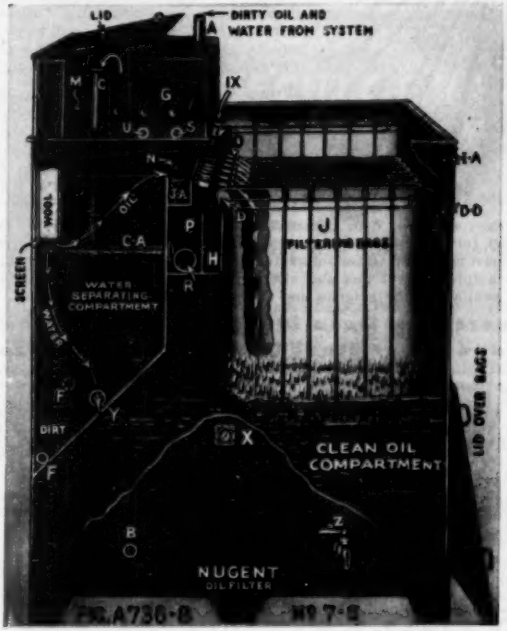

YOU can profit with this simple inexpensive Nugent filtering method. Nugent Gravity Oil Filters operate continuously to filter out dirt, carbon and other harmful impurities that might get into the lube oil and damage vital engine parts. Water is separated and acid neutralized, too. Will not remove additives nor change the original structure of the oil, because no resins or chemicals are used in filtering elements. The multiple Nugent filter bags used can be quickly cleaned without shutting off the filter. And, Nugent Filters *tell you* when they need cleaning — an automatic alarm system built into the filter can be wired to any point in your plant. Find out how Nugent Gravity Oil Filters can help you. Tell us your filtering problems and we will send you full information on the Nugent Filter that best suits your needs.

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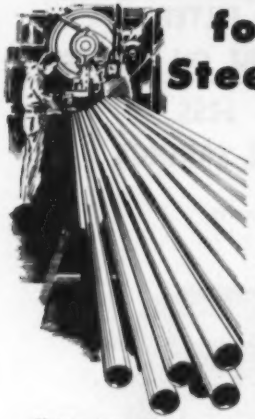
Southeastern Metals Company

selects BIRMINGHAM DISTRICT for South's First Steel Tube Industry



SOUTHEASTERN METALS COMPANY is the first plant making electric welded mechanical steel tubing to locate in the South. So outstandingly successful has its operation proved that a large-scale expansion—including addition of a chrome plating plant—is already under way.

"We placed our plant in Birmingham," says President Robert T. Harris, "because in our opinion a heavy steel using industry like ours must be located at a basing point in close proximity to an abundant source of steel supply. We have found Birmingham's steel rolling mills wonderfully co-operative. This central district tops all others for prompt and economical coverage of growing Southern markets. Other influential factors in our choice of Birmingham were ample natural gas and electricity and abundant industrial water, plus availability of a large and competent labor supply."

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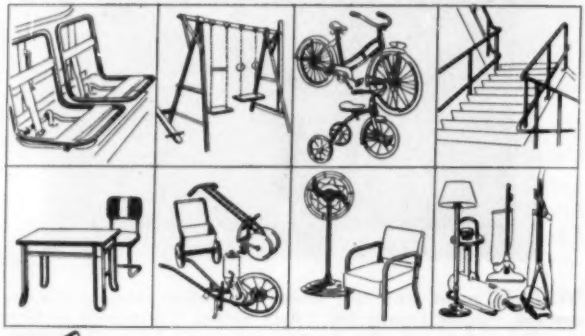

If your plant makes any steel tubing products or equipment sold in the growing South, we invite you to investigate now the superior manufacturing and distributing advantages of the Birmingham district. A comprehensive, confidential survey will be made for you on request by the undersigned Committee. Write and let us know your requirements.

BIRMINGHAM COMMITTEE OF 100

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Centrifugal Pump Instruction Booklets

Two instruction booklets covering the installation, operation and repair of its single-stage, single-suction, and multistage centrifugal pumps have been released by Allis-Chalmers. The booklets include a description of such late developments as "Magic-Grip" couplings, universal joint couplings with "Magic-Grip" bushings, mechanical seals, etc. Section drawings are of a large size for easy reference. Copies of the booklets, 08×7780 and 08×7813—the former covering multistage and the latter single-stage, single-suction centrifugal pumps—are available on request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

Atmospheric Corrosion

"Atmospheric Durability of Steels Containing Nickel and Copper-Additional Exposures Data"—8 pages, including 8 tables and charts, that review recent data and literature on the effect of nickel on atmospheric corrosion in low-alloy high-strengths steels. Observations are based on some specimens after 22 years. Comparisons of results are made for moderate and heavy industrial, marine, and rural atmospheres. Beneficial effects of varying nickel and copper and other alloying elements are discussed. Long continued tests show that it is more significant to compare steels on the basis of how long a time is required to arrive at a given unit weight loss than to compare them on the basis of weight loss suffered in a fixed period of time. Available from International Nickel, Dept. EZ, New York 5, N.Y.

Corrosion Resistant Valves

A new 35-page service bulletin, No. V-217, describing types, sizes, operation, and features and Rockwell-built Nordstrom Corrosion Resistant Valves has been issued by Rockwell Mfg. Co. Special reference is also made to Nordstrom Multiport, steam-jacketed and power-operated valves and their varied applications in the chemical and process industries. The bulletin contains typical analyses of the following alloys: cast iron, steel, semisteel, bronze, Mercoloy, Ni-Resist, stainless steel, nickel, Monel, and Hastelloy B. Tables are included listing approximately 175 different chemicals with their recommended alloy valves and lubricants. A special section is devoted to Nordstrom lubricants and lubricant equipment. Available from Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

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29 W. 39th ST., NY 18, NY

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NEW EQUIPMENT
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LATEST CATALOGS

Power Transmission Equipment

Falk bulletin No. 10,000 briefly illustrates and describes the full line of power transmission products manufactured by The Falk Corp., 3001 West Canal St., Milwaukee 1, Wis.

Helical gears and gear drives from 1 in. to 18 ft in diam; marine drives, large and small; motoreducers, concentric shaft and right angle types; speed Reducers, parallel shaft and right angle; flexible Couplings, Steelflex, and Airflex; high speed drives and special drives are the product descriptions covered.

Double Reduction Speed Reducers

A new 48-page bulletin, No. G-WWH, describes complete line of De Laval double worm and helical-worm gear speed reducers. Complete data is included on horsepower, output torque and center distances for reductions up to 6400:1. Detailed information on how to select double-reduction gearing, examples of selection, horsepower rating tables, dimension sheets, and complete physical data make this an exceptionally useful bulletin. Available from De Laval Steam Turbine Co., Trenton 2, N. J.

Worm Gears

Now available from the Cleveland Worm & Gear Co., 3249-59 E. 8th St., Cleveland 4, Ohio, is a new general catalog No. 400. Its 180 pages illustrate and describe each model in the complete line of Cleveland worm-gear speed reducers as well as worm and gear sets for built-in power transmission applications. The catalog will be helpful in selecting worm gearing and worm-gear speed reducers. It contains engineering and application data on each unit, including dimensions, weights, and rating tables—all the information needed to determine the correct Cleveland drive for your equipment.

Totally Enclosed Variable Speed Motor

Newest product of U. S. Electrical Motors Inc., is a totally enclosed variable speed motor for use in dangerous atmospheres or where dust or drippings may be harmful. This motor is an upright model made in two U. S. Varidrive Types, VEU-SE and VEU-SD and is made in a range from 2000 to 10,000 rpm. It is designed for explosionproof service. Bulletin 1629 gives details. U. S. Electrical Motors Inc., Box 2058, Los Angeles 54, Calif.

Centralized Lubrication

A bulletin, on the Farval Centralized System of Lubrication points out that the system provides these positive benefits:

Saves time—by lubricating all bearings in one minute or less, with equipment in full operation; saves men—with Farval -one man lubricates more bearings than 10 men—does it better and with complete safety; saves power—by reducing friction, Farval cuts power consumption by as much as 20%; saves bearings—Farval increases bearing life 5 to 25 times and conserves critical materials; saves lubricant—eliminates lubricant waste—saves at least 75%; increases production—by eliminating shutdowns to lubricate or to replace bearings.

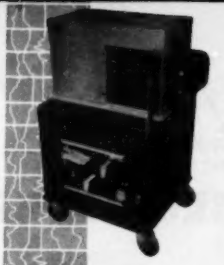
Available from Farval Corp., 3249 E. 8th St., Cleveland 4, Ohio.

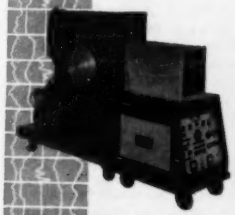
No more worries about
FREQUENCY RESPONSE
or
WRITING SPEED.

The NEW and PHENOMENAL

HATHAWAY Type SC-16
OSCILLOGRAPH

with 6 elements is *flat from 0 to 200,000 cycles per second*, and its traces have a writing speed of *5 million inches per second.*





Fast transients and high-frequency phenomena now can be accurately recorded.

Several types of continuous-drive record magazines are available for 6-inch sensitized paper and film, and for 35-mm film. The magazine shown on the oscillograph at the left accommodates 100-foot rolls of record paper.

Drum-type magazines, both small and large, are valuable for short high-speed records. The large drum-type magazine at the left has a drum 3 feet in diameter and 6-inches wide. It can be driven at 3000 RPM for a *chart speed of 6000 inches per second* when high resolution is needed. It can be used to take one 10-foot record or a larger number of shorter records.

The ASC-10 6-element direct-coupled amplifier will drive the SC-16 oscillograph from potentials of millivolt level.

Useful for strain recording to 100 Kilocycles.

AUTOMATIC OPERATION Initiate a transient with the oscillograph, or let the transient start the oscillograph.

QUICK-CHANGE TRANSMISSION for wide range of record speeds.

PRECISION TIME LINES.

Z-AXIS MODULATION for timing to one-tenth millisecond.

QUICKLY-INTERCHANGEABLE LENS STAGES for different record and trace widths.

Write for Bulletin 2 GIN for details.

Write for FREE copy of Hathaway Engineering News

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

MEASURE IN MICROINCHES RMS

Production Efficiency *increased*

BELL Aircraft CORPORATION

because uses the PROFILOMETER

Bell Aircraft Corporation of Buffalo, New York, in production of Guided Missiles, Supersonic Aircraft, Rocket Motors and Airborne Electronic Equipment finds the Profilometer has increased their production efficiency. At Bell the development of guided missiles is of great magnitude. While the work in this field is of a restricted nature, it can be reported that the Profilometer has become of standard use in production techniques.

A specific example is Bell Aircraft production of high precision valves. Extreme surface accuracy in machining these high precision valves is of prime importance. For these surface measurements Bell turned to the Profilometer for the necessary answers. The I.D. surface of these valves, shown being measured above, must produce a maximum reading of four microinches! Bell found that the Profilometer would give these readings fast and accurately thus saving valuable machining time in production.

Extremely accurate surface measurement is essential to Bell Aircraft today in research and production. The Profilometer is supplying this information. This is just another example of the use of the Profilometer as an important *shop instrument.*

To learn how the Profilometer can help cut costs in your production, write today for these free bulletins.

Profilometer is a registered trade name.

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formerly PHYSICISTS RESEARCH COMPANY
Instrument Manufacturers
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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Long Retracting Soot Blower

The mechanically operated valve recently made standard on Diamond Model IK Long Retracting Soot Blowers is illustrated and described in new bulletin, No. 1055, issued by Diamond Power Specialty Corp., Lancaster, Ohio. Valve operation is shown in detail and the many advantages imparted to the performance of the blower are discussed.

Control Selection

A new 8-page selection guide for a wide range of electric and electronic controls, devices, and accessories is available from the General Electric Co., Schenectady 5, N. Y. Designated as GEA-5781, the bulletin contains quick-reference selection data, photographs, and listings of additional publications which give complete information on each of the equipments. Products included are: manual, magnetic, combination, and reversing motor starters; pushbutton stations; relays; limit switches; solenoids; photoelectric relay; electronic timer; electronic relay; pressure and vacuum switch; float switch; pressure governor; reduced-voltage starter; Thy-mo-trol drive; and smoke density indicator and control.

Jicircuit Guide

A handy, new kit, which gives a quick and complete key to all standard Joint Industry Conference symbols for industrial hydraulics, is offered by the Denison Engineering Co., Columbus, Ohio, to those whose work is directly concerned with hydraulic designing, engineering, or circuit application. This kit provides easy reference and worksaving adaptation to circuit diagrams by simplifying planning, making diagrams easier to read or draw, and by saving time wherever JIC symbols are used.

The kit is made up of two units—a sturdy plastic drawing template containing basic elements of all JIC symbols, and a 32-page booklet in which all key examples of circuit components are represented by symbols approved by the Joint Industry Conference for industrial equipment. Accompanying each symbol is a reference to the Denison catalog describing that particular piece of Hydr-OIL ic equipment as manufactured by Denison.

Plastigels

The preparation, properties, and uses of the new formulation of Vinylite dispersion resins known as plastigels are described and illustrated in a new booklet published by Bakelite Co., a Division of Union Carbide and Carbon Corp., 300 Madison Ave., New York 17, N. Y. Technical data on these puttylike substances which can be processed at room temperatures with low pressures and yet retain their shape to the smallest detail is presented in 16 pages of text, photographs and graphs in the booklet, "Vinylite Dispersion Resins—Plastigels". Advantages such as lower machine and mold costs, made possible by the lower pressure required to fabricate plastigels of Vinylite resins by many conventional methods are explained in the Applications of Plastigels section. Production benefits are suggested under possible applications of plastigels in tubing and sheeting, embossing, calendering, hand modeling, potting compounds, cloth and paper coatings, and dip coatings. A bibliography lists some of the articles which have been published on this subject.

Keep Informed

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Self-Cleaning Pipe-Line Strainers

A new 4-page bulletin, No. 252, describes the complete line of Anderson self-cleaning pipe-line strainers made in sizes from 1/4 to 3 in. An interesting discussion titled "Value of Sediment Control" points out the numerous pieces of pipe-line equipment needing strainer protection. These include steam traps, reducing valves, air tools, pumps, temperature regulators, etc. In addition, the bulletin contains complete specifications and prices on the product. Features discussed by the manufacturer include mesh-type Anderson stainless-steel strainer screen, low initial cost, self-cleaning feature when blow-down valve is used, and exceptional life. For a copy, write to Wm. J. Gleason, Jr., manager, Steam Specialties Division, The V. D. Anderson Co. 19, Cleveland 2, Ohio.

Textile Industry Motors and Controls

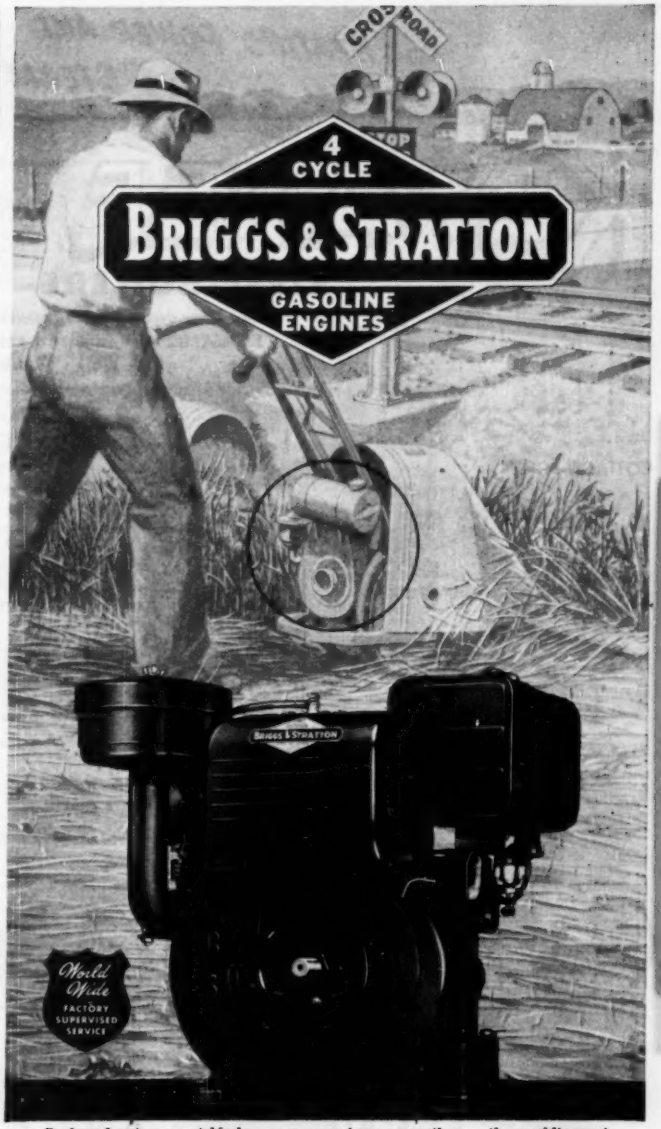
"Undivided responsibility" for application of both motors and their controls to the textile industry is the theme of a new 32-page booklet available from Westinghouse. Problems common to the textile industry are discussed—such as lint clogging, shock and vibration, corrosion, and speed and tension control—and it is shown how solutions can be obtained through correct use and selection of both motors and controls. In addition, eight case histories provide, in the user's words, an actual sampling of the benefits to be gained by co-ordinated application. For a copy of this booklet, B-5422, write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Vertical Transportation

A new 24-page, two-color brochure is available from the Otis Elevator Co., 260 Eleventh Ave., New York 1, N.Y., entitled "Vertical Transportation by Otis." This publication describes the complete line of Otis equipment and services for vertical transportation including separate sections on passenger and hospital elevators, escalators, dumbwaiters, and freight elevators, elevator modernization and maintenance programs. Thirty-six photographs and line drawings illustrate the text and 17 tables provide dimensions and engineering data. Several systems for passenger elevator traffic control are described including the autotronic control system.

Long-Wearing Machinery Parts

A wide variety of cast and wrought alloy parts now being used in many industries to solve abrasion, corrosion, and high-temperature problems is described in a new 24-page booklet, "Long-Wearing Machinery Parts." More than 60 blueprints, tables, and photographs show some of the sizes and shapes in which these Haynes alloy parts are being used. The booklet is available from Haynes Stellite Co., a Division of Union Carbide and Carbon Corp., 30 E. 42 St., New York, N. Y. The parts described are made of the various Haynes cobalt-, iron-, and nickel-base alloys which have had wide use as metal-cutting tools, jet aircraft parts, chemical equipment, and many types of valves and furnace parts. For the benefit of those who may have a particular machinery part which has failed repeatedly, there are information forms included in the booklet. When filled out to describe the maintenance problem involved, this form will help assure that the right alloy is recommended for the job.



Preferred power on sickle-bar mowers and power scythes — the world's most widely used single-cylinder gasoline engines on hundreds of kinds and types of machines, tools, appliances, used by industry, construction, railroads, oil fields, and on equipment for farms and homes.

WHEN you want the best in machines, tools, appliances — equipped with the best air-cooled power — you will be sure if they are powered by Briggs & Stratton — the recognized leader in single-cylinder, 4-cycle, air-cooled gasoline engines. Briggs & Stratton Corporation, Milwaukee 1, Wisconsin, U.S.A.

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STEEL BOILERS

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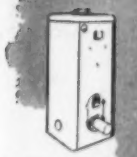
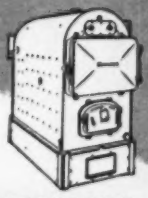
In sizes and types to produce 77,000 to 10,200,000 Btu hourly for low pressure heating . . . or develop from 7 to 504 horsepower . . . there is a Kewanee just right for the purpose.

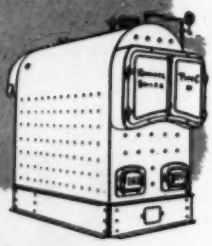


COTTAGE BOILER

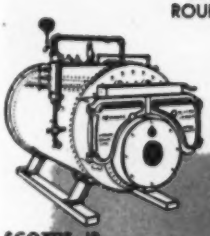
Jacketed ROUND "R"



SQUARE HEAT for medium size buildings



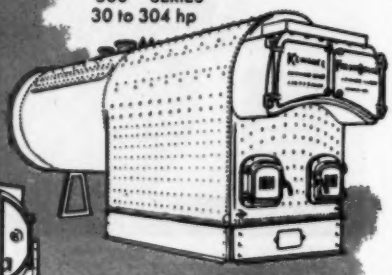
TYPE "C" for large buildings



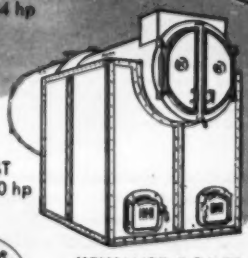
SCOTTIE JR. 7 to 36 hp

FOR POWER

H M SCOT 52 to 304 hp



"500" SERIES 30 to 304 hp



HI-TEST 60 to 180 hp

KEWANEE BOILER CORPORATION
KEWANEE, ILLINOIS
Division of American Radiator & Standard Sanitary Corporation

Heating America's Finest Buildings

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Instrumentation

The "Fundamentals of Instrumentation for the Industries" is the title of booklet 80-2, which consists of 126 pages. It covers the fundamentals of measurement, control, and transmission of variables encountered in industry. Typical applications are also discussed. Available from Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Aves., Station 40, Philadelphia 44, Pa.

Vertical Induction Motors

Construction features and types of Allis-Chalmers large vertical induction motors widely used for pumps and other vertical drives are described in a new bulletin released by the company. The bulletin explains that except for bearing arrangement, the mechanical construction of vertical solid shaft induction motors is basically the same as that of horizontal units. The vertical motors are customarily of the open, self-ventilated type. However, they can be provided with the same protective features and enclosures as horizontal machines of corresponding ratings and temperature rise. The bulletin covers motor ratings in 40 C, 60 cycle from 60 hp, 200 rpm to 800 hp and larger at 1800 rpm. Copies of the bulletin "Large Vertical Induction Motors," 05B7629 are available upon request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

Cone-Drive Gears

Individual bulletins are available from Cone-Drive Gears, Division of Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich., to those interested in geared drives requiring simple and compact high load capacity, double enveloping gear sets, and speed reducers or torque amplifiers. The bulletins include the following: Bulletin No. 501, Car Unloader capacity increased more than 250%., No. 502, Farm conveyer utilizes the compact features of double enveloping gear reducers; No. 503, Beverage mixing machine has double enveloping gears built into base; oil well cementing company uses 15½-in. center distance Cone-Drive gears to handle 141 hp at 150 rpm; knitting mill motorizes rotary knitting machines with Cone-Drive reducers; No. 504, Built-in gearing replaced by standardized Cone-Drive reducer units in various applications; No. 505, Steel strip wind-up capacity increased with smaller reducer; No. 507, Cubical butter churn driven through compact reducer in machine housing; No. 508, Steel plate shear capacity increased and design streamlined with Cone-Drive Gearing; No. 509, Tumbling machine and loaders use Cone-Drive reducers for trouble-free service and space saving; No. 510, Seven compact Cone-Drive reducers simplify Board Former machine design; No. 511, Small reducer handles big locomotives; aircraft wing flap actuating mechanism weight and size reduced with Cone-Drive Gears; No. 512, How to save space with fan-cooled reducers; No. 513, Standardized double-reduction reducers made up by combining standard single reduction Cone-Drive units; No. 514, Conveyors use pivoted Cone-Drive reducers for easy access to machines; No. 516, Steel mill equipment moves smoothly with double enveloping Cone-Drive gearing; No. 517, Cost savings through use of fan-cooled reducers; No. 522, Designing compact machine drives with Cone-Drive gearing.

Copyflex Process

A new 8-page, two-color booklet, No. A-2008, describing the Bruning Copyflex process, which has proved of value to American business and industry everywhere, is available from Charles Bruning Co. Inc., Teterboro, N. J.

Utiliscope

Bulletin 1025-A illustrates the new Model 300-B Diamond "Utiliscope" (Wired Television for industrial and commercial uses) and describes its many advantages and typical uses. Technical information including circuit design is also given. This is a supplement to the more comprehensive "Utiliscope" catalog designated as Bulletin 1025 and is available from Diamond Power Specialty Corp., Lancaster, Ohio.

Atomic-Hydrogen Arc-Welding Equipment

A new, two-color, two-page bulletin on single-phase, 60-cycle atomic-hydrogen arc-welding equipment is available from the General Electric Co., Schenectady 5, N. Y.

In addition to explaining the process of atomic-hydrogen welding, the new bulletin, GEC-598A, gives a description of the recently redesigned power-generating equipment and lists its specifications, applications, and advantages. It also covers the features of the company's atomic-hydrogen torch.

Deaerator

A new 4-page bulletin, No. 3677, describing the Permutit deaerator with internal direct contact vent condenser has been prepared by The Permutit Co., 330 W. 42 St., New York 36, N. Y. Many advantages of this unit, which heats and deaerates water in three stages, are outlined in this bulletin.

Flexible Metal Hose

An illustrated bulletin describing Stayput flexible metal coolant hose has just been released by Flexonics Corp. This bulletin, which includes three types of CMH coolant hose, gives complete information on standard lengths and sizes. For a copy write Flexonics Corp., 1305 South Third Ave., Maywood, Ill., requesting bulletin CHC-52.

Hand Trucks

A 12-page condensed truck catalog, Form 508-B, has been released by the Howe Scale Co., Rutland, Vt. Specifications and illustrations are shown for the complete line of the latest Howe two and four-wheel hand trucks, trailer trucks, baggage wagons, platform skids, dollies, lift jack systems, wheels, casters, and molded-on rubber tired wheels. This catalog also shows modern Howe construction features engineered for long, trouble-free and economical materials-handling service.

Boiler Feed Pumps

Bulletins 230, 241, 244, and 246 on two, four, and six-stage boiler feed pumps covering pressure ranges between 350 and 1200 psi; also Horizontal Duplex Piston Pumps in 250-400 psi, are available from Warren Steam Pump Co., Inc., Warren Mass.

Oil Valves

Catalog No. 719 available from Hauck Mfg. Co., 124-136 Tenth St., Bklyn 15, N. Y., covers new Series "D" and "E" Micro-Metering Oil Valves for large capacities and a full lever travel of 180 deg. Besides controlling the flow of oil to oil burners the valves are also applicable for accurate control of vegetable oils, syrups, water, chemicals, and other fluids.

Bulk-Flo Conveyers

A new booklet of information on Bulk-Flo conveyers and elevators has just been published by Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., and is now ready for distribution. This 28-page Book No. 2475 contains photographs of the Bulk-Flo in a wide variety of applications, together with typical layout drawings, engineering data, calculation tables, charts and formulas. Over 150 materials are analyzed for average weight and such characteristics as size, flowability and abrasiveness.

SPRAY NOZZLES... two guides to proper selection!

No matter what you may face in the way of a spraying problem, it can be solved quickly and at low cost with Spraying Systems Spray Nozzles. Two fact-packed catalogs—No. 22, General Industrial Spray Nozzles, and No. 23, Pneumatic Atomizing Nozzles—are yours for the asking. They show you all the various types of spray nozzles available . . . explain design and construction . . . and outline spray characteristics such as atomization, impact of spray and capacity. Write for your copies today.

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ENGINEERS AND MANUFACTURERS
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WRITE FOR CATALOGS NO. 22 AND NO. 23

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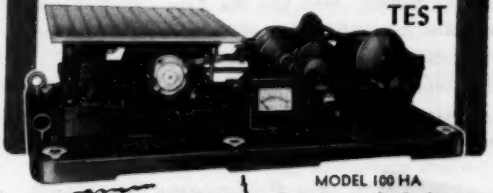
VIBRATION TEST



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MODEL 100 HA
Capacity 100 Lbs. Produces Vibrations horizontally. All controls in easy reach.

NATIONAL Bureau of Standards uses four, Mass. Inst. of Technology two, Western Electric 13, Westinghouse and G. E. 12 each. Basic Equipment for YOUR testing laboratory or inspection department. In many plants a laboratory in itself. Detect excess weight—find structural weak spots.

For electronic, automatic aircraft, crystal, optical and instrument makers, schools and research laboratories. Models to test parts from a few ounces to 100 lbs. Choice of horizontal or vertical table movement. Frequencies of 600 to 3600 v. p. m. Automatically or manually controlled. Send for Catalog F.

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"Buffalo" *Tips on Getting the Best Service from your* **Fans**

PICK THE FAN TO SUIT THE PLAN!

"Buffalo" Type "B" Vaneaxial Fan

The AXIAL FLOW FAN

Forms a Straight Duct Suction

For ventilating and Air Conditioning service, where your piping will be straight, this Axial Flow Fan is ideal. Fitting in as a section of pipe, it requires little more cubic space than does the pipe. "Buffalo" Fans like the Type "B" Vaneaxial above, are also relatively light, which reduces installation cost. Also, this type of fan is unusually efficient in these straight duct runs. Another advantage in "Buffalo" Axial Flows is their limit-load characteristic—you cannot overload them, regardless of system pressure.

For Performance Curve
and other useful information on "Buffalo" Axial Flow Fans, write today for Engineering Bulletin 3533-C

The Centrifugal Fan,
like this "Buffalo" Limit-Load Fan, forms a built-in 90-deg. elbow. If your system is to have many curved connections, consider this type of fan. Details are in Bulletin 3737. Write for your copy.

"Buffalo" FIRST FOR FANS

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PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

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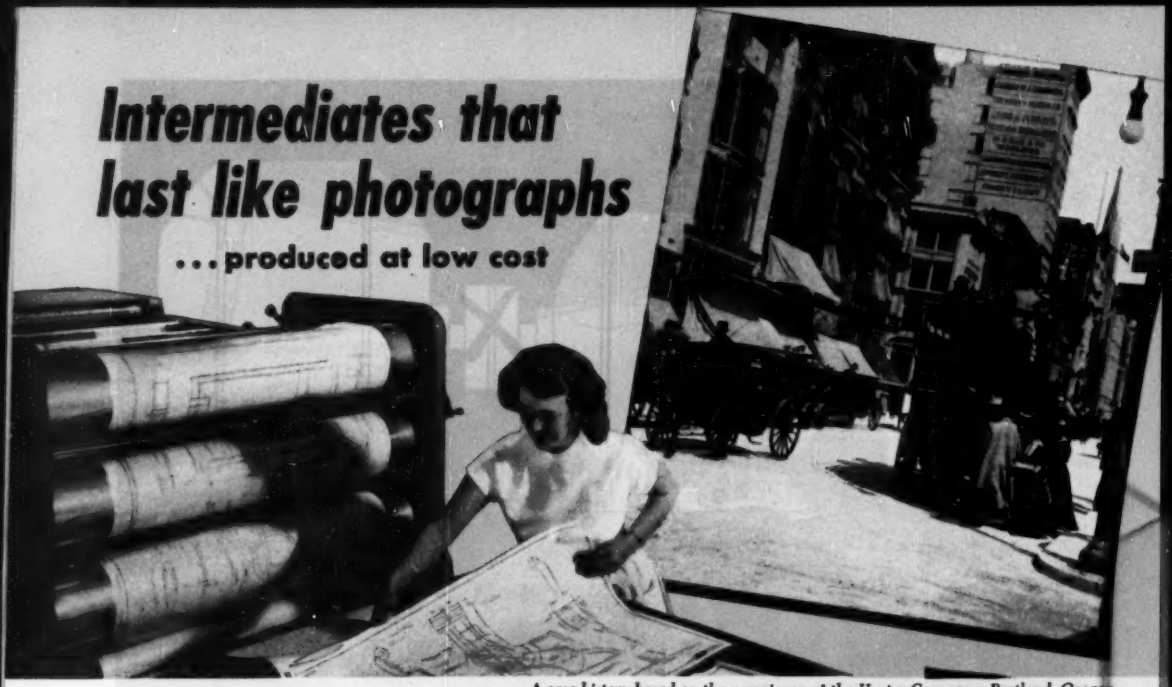
...produced at low cost



A case history based on the experience of the Hyster Company, Portland, Oregon

By reproducing its engineering drawings on Kodagraph Autopositive Paper, the Hyster Company gets intermediates which have dense black photographic lines on a translucent, highly durable paper base. *Intermediates* which will remain intact in the files year after year . . . and produce sharp, legible blueprints and direct-process prints whenever needed.

And the cost is surprisingly low because Kodagraph Autopositive Paper boasts unique photographic properties which cut production costs *substantially*. It can be handled in ordinary room light . . . and it produces positive copies *directly*—without a negative step.

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How The Hyster Company Uses Autopositive

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For Drafting Room Short Cuts. Autopositive Paper is used to reclaim old and weak-lined drawings . . . and to duplicate standard designs which will be incorporated in new drawings. *All of which saves hours of creative drafting time.*

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

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Learn in detail all the ways you can use Kodagraph Autopositive Paper — the revolutionary photographic intermediate material which you, or your local blueprinter, can process *quickly . . . economically . . . at a low cost.*

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Industrial Photographic Division, Rochester 4, N. Y.

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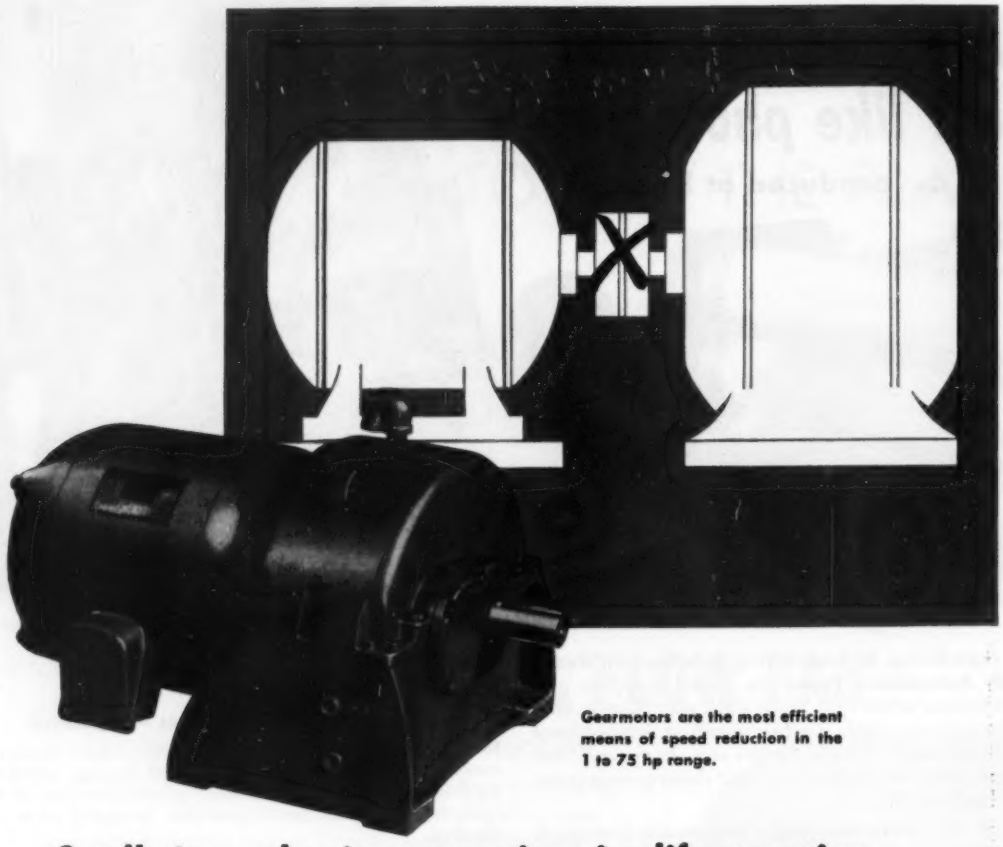

Gearmotors are the most efficient means of speed reduction in the 1 to 75 hp range.

Small size and unit construction simplify mounting of Life-Line GEARMOTORS

Gearmotors provide the ultimate in compactness. Life-Line Gearmotors give you this compactness, plus many exclusive features not available in any other make. When mounting space is at a premium—Life-Line Gearmotors simplify the problem.

They are self-contained . . . can be installed quickly and conveniently. There's no handling, mounting and aligning of a separate motor, coupling and subbase or bedplate.

Life-Line Gearmotors also offer you these advantages: fewer moving parts, require less maintenance—are easier to inspect and service—are designed, built and serviced by ONE manufacturer.

Use the most efficient means of speed reduction. Use Life-Line Gearmotors. Call your Westinghouse representative for the facts, or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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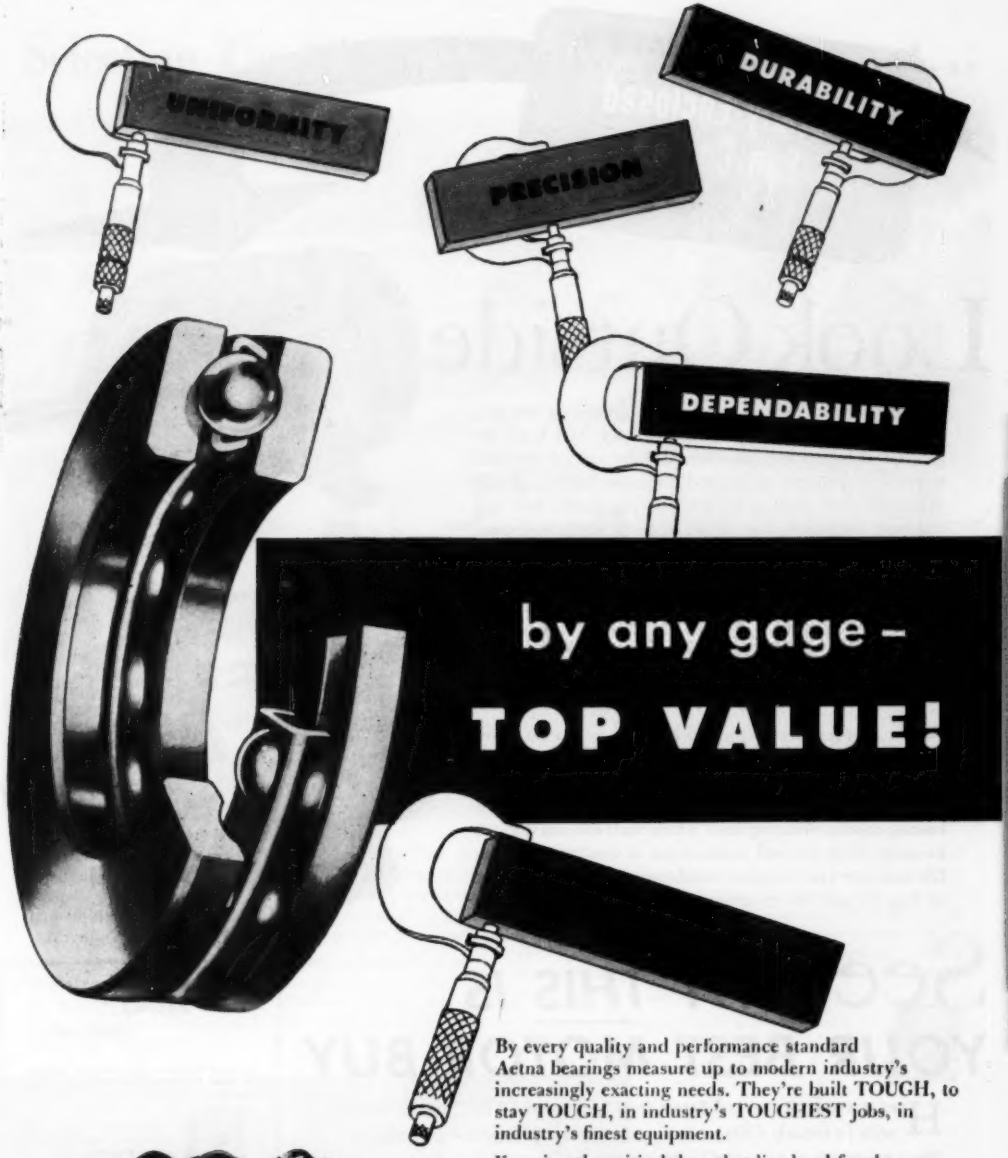
You can be sure...if it's Westinghouse

Life-Line GEARMOTORS



by any gage –

TOP VALUE!

By every quality and performance standard Aetna bearings measure up to modern industry's increasingly exacting needs. They're built TOUGH, to stay TOUGH, in industry's TOUGHEST jobs, in industry's finest equipment.

Knowing the critical days that lie ahead for the equipment YOU make or use, it stands to reason you'll place more emphasis on the quality of the bearings you buy and the anti-friction engineering service you employ. In that direction we have no better sales talk to offer than the fact that we serve the Nation's foremost manufacturers—that 80% of our business comes from firms we have served for 20 or more of our 36 years.

Aetna

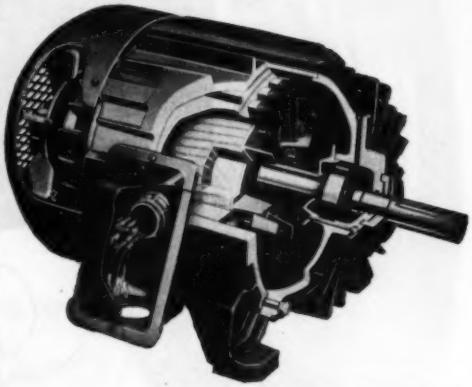
Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings.

AETNA BALL AND ROLLER BEARING COMPANY
4600 Schubert Avenue • Chicago 39, Illinois

Look Outside

Greatly increased radiating area means greater cooling efficiency. More important, cooling efficiency stays high, regardless of operating conditions. There are no enclosed external air passages to clog and cause overheating. If oily dirt sticks, just wipe or blow it off. No matter how bad operating conditions are, this motor can be easily kept clean and cool running. Electrical parts are protected against corrosive atmospheres by cast iron yokes and end housings.

Look Inside



Double-shielded, heavy-duty ball bearings require no maintenance in ordinary service under most conditions. However, they can be lubricated without disassembly if required. Double shielding prevents over-lubrication, leading cause of bearing trouble. Rotating seals, where shaft extends through housings, keep dirt and moisture out of bearing chambers. Die cast rotor and interphase insulation are further assurance of long life and low maintenance.

See WHY THIS IS YOUR BEST MOTOR BUY

HERE IS A MOTOR that is different from conventional TEFC motors; built with an entirely different cooling system that gives you big savings in lower maintenance, more continuous service and less trouble in the toughest locations. Clogging can easily be prevented in the Allis-Chalmers Type APZ TEFC motor since areas that might collect dirt are exposed and easy to clean.

GET DETAILS NOW — *Ask your nearby Allis-Chalmers Authorized Distributor or District Office for more complete information on this high performance TEFC motor. Or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7225.* A-3578

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

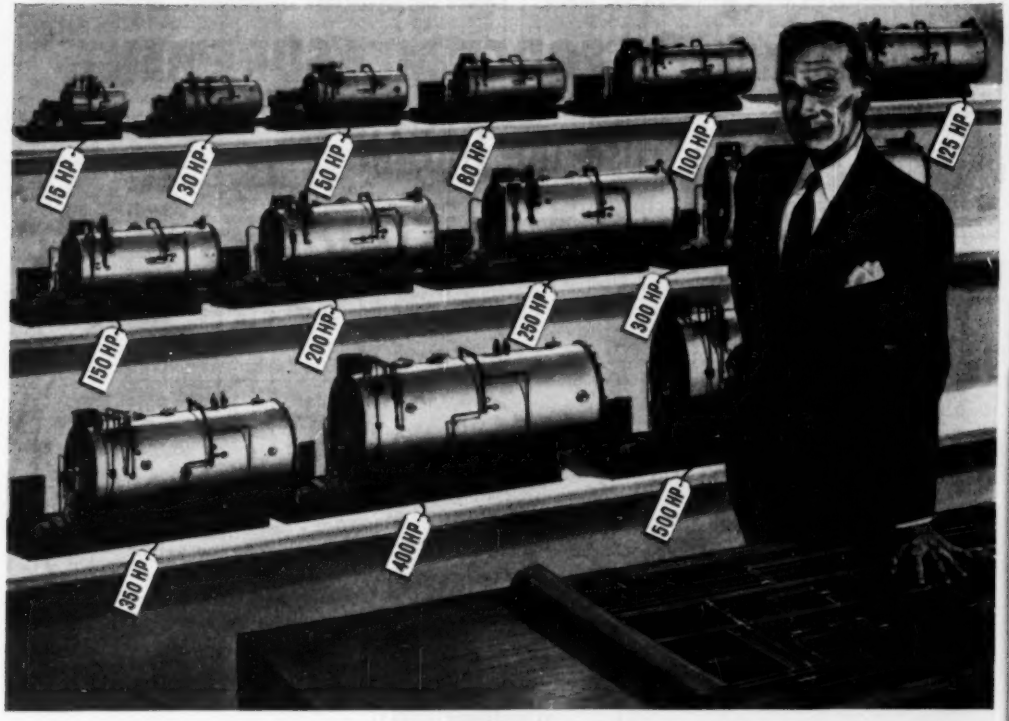
CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

ALLIS-CHALMERS

Selecting The Right Boiler Is Most Important...

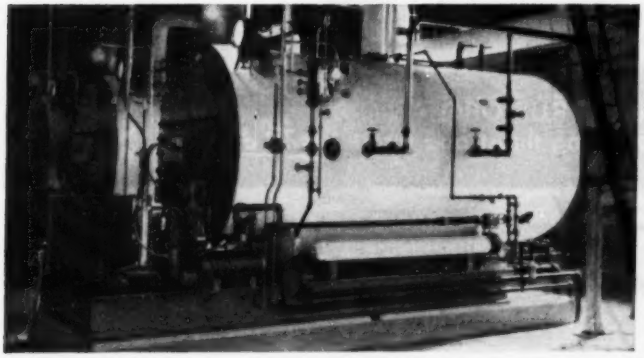


Cleaver-Brooks does not sell steam boilers "off the shelf" even though the boilers are available in standard models. Working with you, your engineers, and your consulting engineers Cleaver-Brooks helps analyze your particular steam needs and loads, both present and future.

These are a few of many factors considered: steam requirements in pounds per hour or b.h.p. — constant or fluctuating loads — fuels available — electric current characteristics — space and boiler room layout — provision for expansion.

Application engineering assistance of this kind assures you a steam plant tailored for your job. Cleaver-Brooks are the first and finest in modern, self-contained steam boilers — operate at a guaranteed efficiency of 80% — burn the fuel most available and economical in your area, gas, oil, or combination gas and oil — fully meet all codes — standard models available in sizes 15 to 500 hp; 15 to 250 p.s.i.

Write for latest, fully illustrated and descriptive Cleaver-Brooks Steam Boiler catalog.



Cleaver-Brooks
STEAM BOILERS

CLEAVER-BROOKS COMPANY
Dept. G-318 E. Keefe Ave., Milwaukee 12, Wis., U.S.A.
Cable Address: Clebro-Milwaukeewis

Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

For versatility in **FORCE MEASUREMENT**

use the HAGAN

air-operated THRUSTORQ

The Hagan THRUSTORQ translates a force or weight into a pneumatic signal pressure. This pressure reports the force or weight accurately and dependably to indicating or recording instruments, or to an automatic control system.

Some typical applications of Hagan THRUSTORQ include:

- testing piston rings
- jet engine thrust measurement
- rocket thrust measurement
- spring testing machines
- automatic batch weighing
- dynamometer testing of electric motors, hydraulic pumps or internal combustion engines

HAGAN THRUSTORQ
measuring thrust and torque *with air!*

HAGAN
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BUROMIN
CALGON

For information about the application of Hagan THRUSTORQ to your particular problems, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

NEW!

High Speed
Low Price
Premium Prints

the COPYFLEX "30"

Here, for the first time, is a copying machine — Bruning's remarkable Model "30" COPYFLEX — that combines such a relatively *high speed* with such a *low price* and such *premium quality*, ready-to-use prints.

The "30" is ideal for the drafting room or office with medium volume requirements and a moderate budget. It handles cut sheets or roll stock up to 42 inches wide, and offers features ordinarily found only in larger, more expensive machines.

With the "30" and the unsurpassed line of sensitized COPYFLEX papers, cloths and films, you can always get the kind of premium prints you want, when you want them.

Why wait on inadequate equipment or for "outside" copying? See how the COPYFLEX "30" can save your time, cut your costs. Just send in the coupon *now!*

MODEL "93"—finest of copying machines. There's a COPYFLEX machine that's just right for every price and volume requirement.

Only *COPYFLEX* gives you all these advantages!

- Premium quality prints ready for immediate use
- No installation — simply make an electrical connection
- No fumes or exhausts because it uses no vapor developer
- Unexcelled range of sensitized papers, cloths and films
- Anyone can operate a COPYFLEX machine with a simple 5-minute explanation

BRUNING

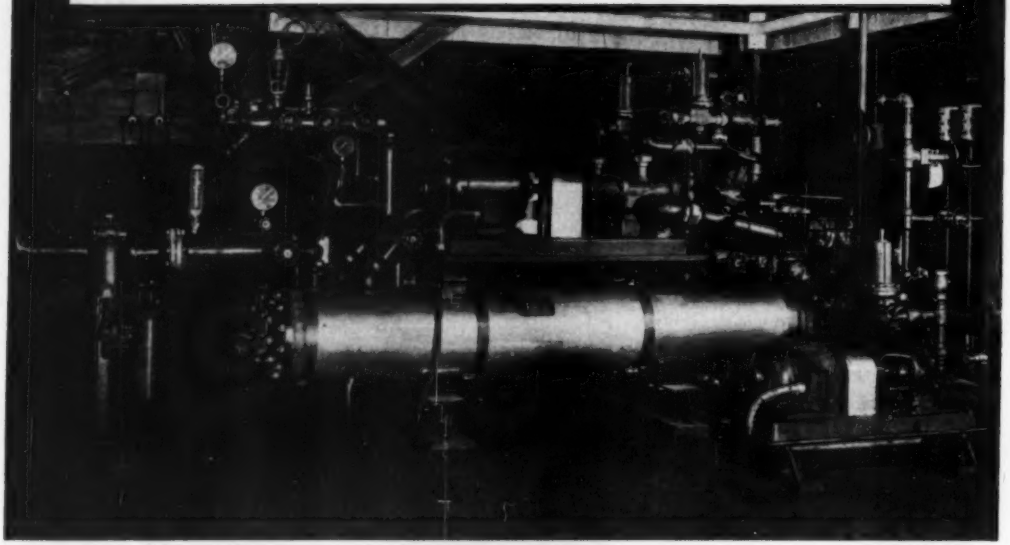
Specialists in copying since 1897

CHARLES BRUNING CO., INC.
Dept. H-62 Teterboro, New Jersey

☐ Send me free booklet on COPYFLEX "30."
☐ Show me COPYFLEX in action (no obligation).

Name ..... Title .....
Company .....
Street .....
City ..... Zone ..... State .....

2 separate ENCO Fuel Oil Units Meet Plant Needs



Here is a typical Enco two-unit installation which handles fuel oil pumping and heating requirements in the plant of a building materials manufacturer.

Fuel Oil Pumping and Heating Unit, built with two pumps and two heaters, is designed for continuous plant load service. Capacity is 11 gpm Bunker C fuel oil with one pump or one heater at 300 psig pressure with a temperature rise from 90F to 230F.

Light Oil Pumping Unit for cold start-up service. Capacity is 3 gpm #2 oil at 300 psig pressure.

Enco pump sets are designed to give you easier control and longer maintenance-free operation. They are simple and economical to install. All you need do is to connect to station piping and run. Before shipping, every Enco Fuel Oil Pumping and Heating Unit is completely tested under high pressures. For complete details on wide-range line, write for Bulletin O B -37.

Only ENCO offers all ten plus features

1. Completely Automatic Operation is assured by automatic temperature and pressure regulation valves.

2. Coordinated Design Saves Space. All equipment essential to the preparation of fuel oil for combustion is contained in one compact unit.

3. Individually Designed to meet the specific needs of the particular power plant in accordance with its exact operating requirements.

4. All Parts Visible and Accessible for easy operation, maintenance and repair.

5. Pumps and Heaters are interconnected to provide maximum flexibility of operation.

6. Safety Valves protect individual parts where required.

7. Easier Maintenance — Less Service-Time for Cleaning because straight tube, multi-pass heaters with removable heads are used.

8. Pumps Operate at Moderate Speed. Heaters designed to give the correct viscosity and velocity without fouling.

9. Smoother Flow of Clean Fuel to Furnace. Air chamber for each piston pump prevents pulsations—pressure regulator for rotary pumps. Twin type strainers provided to keep atomizer tips from clogging.

10. Cleaner Boiler Room . . . all overflows connected to a common outlet, flanged drip pan catches oil drip.

EC 405

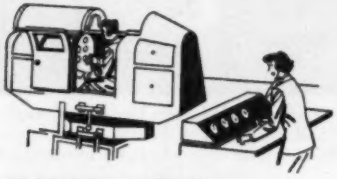
THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, N. Y.

IN CANADA: F. J. RASKIN, LTD., 4220 IBERVILLE ST., MONTREAL 34, P. Q.

American Blower . . . a time-honored name in air handling

Salt Lake City has a conveniently located American Blower Office to provide you with data and equipment for air handling. You can reach American Blower in Salt Lake City by calling 4-6421. In other cities, consult your phone book.

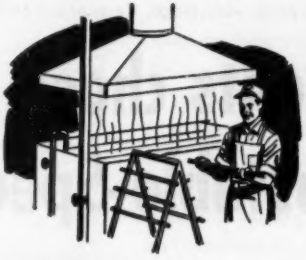


PRECISION TESTING

Long before aircraft instruments are accepted for use, they are thoroughly evaluated in special laboratories. And in the testing of precision instruments, as with many other processes, close control of temperature and humidity is vital. Recently one of the newest and largest instrument laboratories selected American Blower equipment for heating, ventilating and temperature control – a fine compliment not only to American Blower quality but also to our own research and testing methods.

DO AWAY WITH DUST

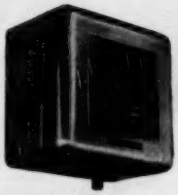
If you have a problem involving dust or fly ash collection, American Blower will be glad to help you. We have a wealth of experience in this field which covers both dust and fly ash removal in industry and public utilities as well as the recovery of valuable materials from air. In addition to local, on-the-spot assistance from our branch office personnel, a modern fully equipped research laboratory is maintained in Detroit to serve you.



FUME REMOVAL

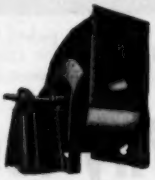
If you're planning to enlarge your metal-processing facilities American Blower offers special fans to handle the corrosive fumes, gases or vapors. For example, some corrosive gases are necessary to process work and must be circulated in the system with corrosion-resistant fans. In other cases, fumes and gases which affect the health and comfort of employees must be safely and effectively removed.

Whatever your requirements American Blower heating, cooling, drying, air conditioning and air handling equipment will improve over-all comfort and efficiency in your business. For specific information, phone or write our nearest branch office.



Unit Heaters

Ventura Fans



Industrial Fans

Utility Sets

You are cordially invited to visit the
AMERICAN BLOWER EXHIBIT
at the 1952
NATIONAL PLUMBING & HEATING EXPOSITION
Convention Hall, Atlantic City
June 2-5, 1952

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
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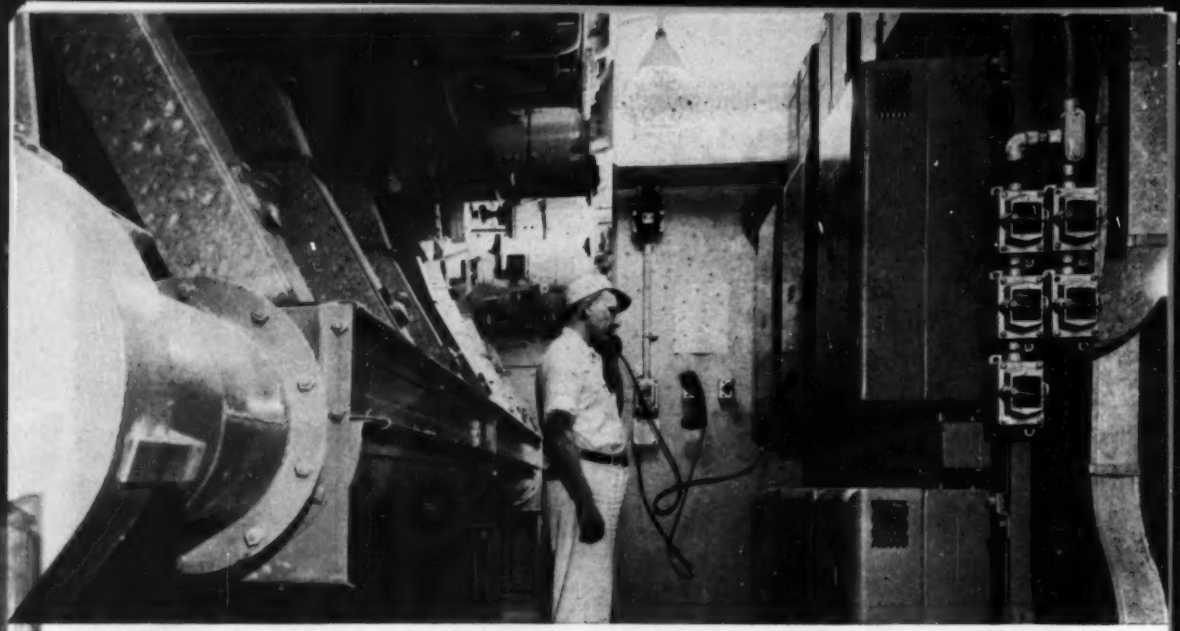
YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • AERO CABINETS • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • THOMPSON ICED



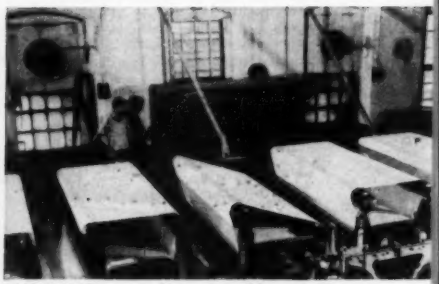
GENERAL MILLS, INC. picked G-E *Thy-mo-trol*® drives to proportion and control flow rate of flour. They wanted stepless, very accurate, electronic speed control over a wide range, plus quick, easy operation. The answer: *Thy-mo-trol*, available in ranges to 100:1 and more, ¼ h.p. and up. Above, operator gets orders over phone, sets drive speed quickly by turning dial.

Why four plants chose four different G-E Adjustable-Speed Drives!

JACK & HEINTZ, INC. chose G-E *Speed Variators* because they wanted to increase production with rotating, adjustable-speed drive that could be operated from centralized control—still maintain good quality over a wide speed range.

◀**BUTTERICK CO. INC.** found G-E *ACA Motors* ideal for varying speeds over moderate range for offset presses. Here is the simplest, low-cost way to get stepless, adjustable-speed drive with a-c power, contains motor, control in one compact unit.

®Reg. Trade-mark of General Electric Co.

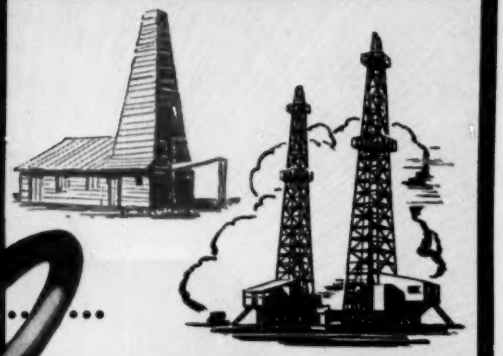


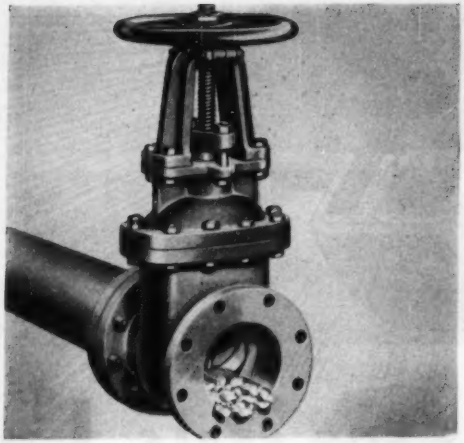
CRANE & CO., manufacturers of fine paper, selected G-E *Electronic Speed Variators* for paper machines—needed a 40 h.p. adjustable-speed drive that maintained rigid quality control, automatically, 24 hours a day, six days a week.

GENERAL ELECTRIC CO. is the only manufacturer making *all major types* of electric adjustable-speed drives to help you speed output, raise quality. Write for 24-page *Bulletin GEA-5334. General Electric Co., Schenectady 5, N. Y.* 646-18

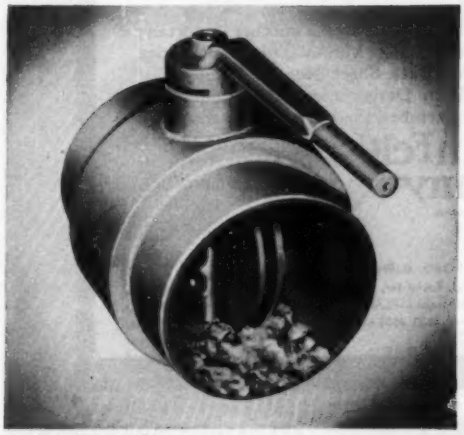
GENERAL ELECTRIC

Results from designing for greater efficiency... ... ...





CONVENTIONAL GATE VALVE



MUDCO BUTTERFLY VALVE

More . . . MORE . . . MORE . . . *MORE* oil! *These demands* cannot be met with obsolete equipment. New, better methods and equipment must be designed to increase production, reduce "down-time" and maintenance costs!

LINEAR is playing a more important role in designing for greater oil production. For example, shale and other debris, settling in the seat of the conventional gate valve prevents a perfect seal, thus causing leakage, costly shut-downs and replacement time.

LINEAR "O" Rings, fitted to the disks of Mudco Butterfly Valves, solve the problem. During closure, the "O" ring acts as a wiper, removes the shale, and effects a tight seal. Metal-to-metal wear is entirely eliminated. And, when replacement is finally necessary, the valve is renewed simply by replacing the "O" ring *in the field* without costly machine shop repairs.

To build it better . . . make it simpler . . . to achieve greater efficiency, consult LINEAR in the design stage, to help you with your packing and sealing problems.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA

AMERICAN FELT FOR SEALS

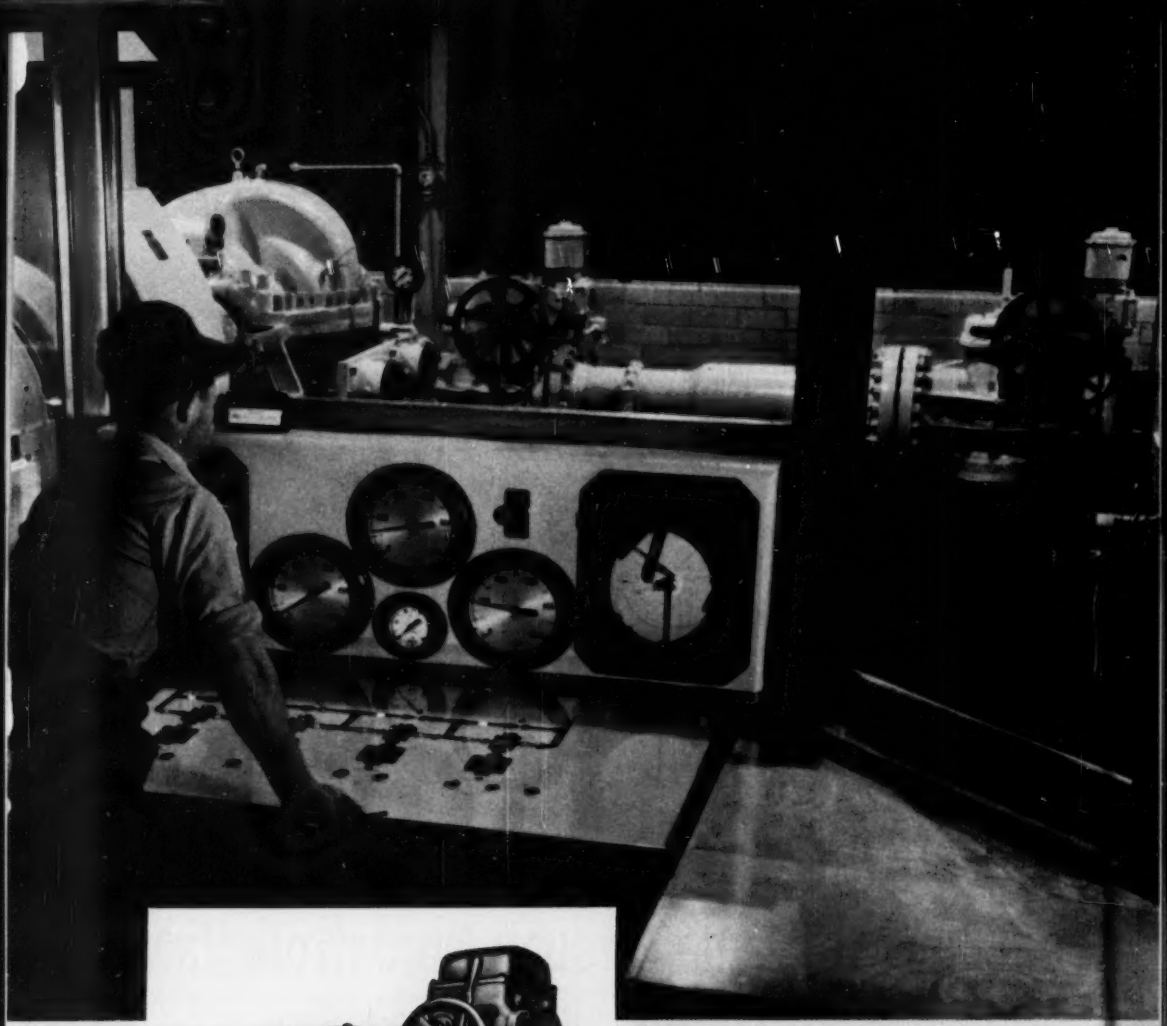
American supplies special felts for seals. These are ideal materials for bearings, rotating shafts, housings, and similar applications. In many cases, such seals provide lubrication, and no attention is required between major overhauls. Lifetime sealing for ball bearings is another important application. For full information, write for Data Sheet No. 11, "Felt Seals, Their Design and Application." And remember, there are 15 other mechanical functions which felt can perform in your plant or product.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.



Rockwell | **Built Nordstrom Valves**

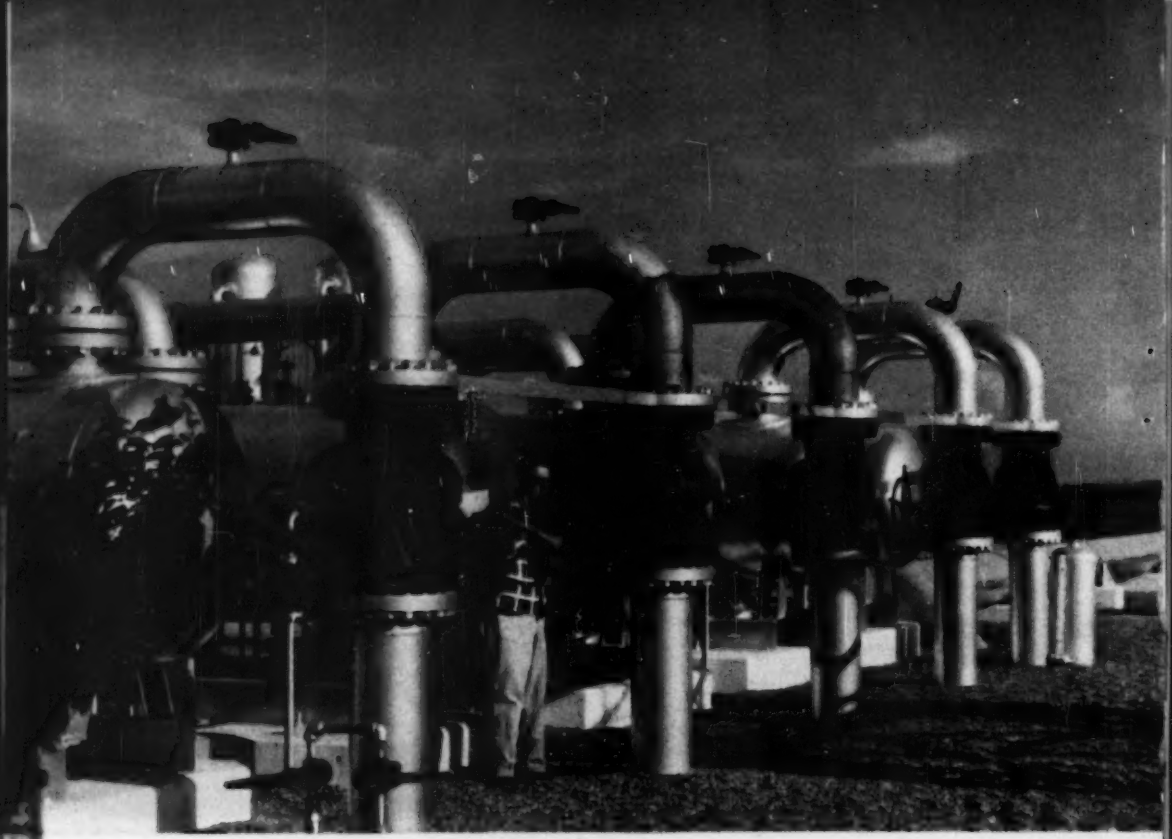
Another Rockwell Product

LUBRICANT SEALED TO KEEP UPKEEP DOWN

NOW WITH NORDSTROM

You Can Centralize and Mechanize Flow Control

With Nordstrom automatic control valves a single panelboard operator can completely command all lines of flow. From one location, he can tell at a glance which lines are open and which are closed. In an emergency, operation is instant. Complex batching and blending processes, dependent upon timed cycles, become simple. Manpower is saved. Valves miles away can be operated at the touch of a finger. Nordstrom power operated valves enable you to mechanize your flow control and centralize flow line operation.



From Field to Flame Through Nordstrom Valves

At each stage, from the time it comes from the ground, through processing, pipe line, distribution and finally use, natural gas is controlled by Nordstrom valves.

The same can be said for petroleum.

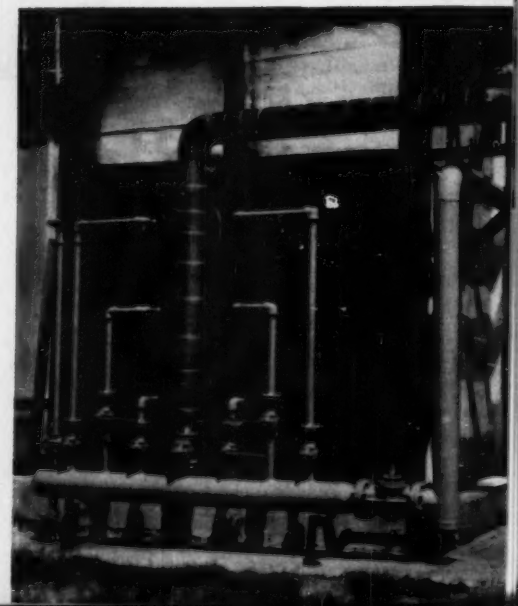
The same can be said for many chemicals.

Nordstrom valves have been used successfully in perhaps more different kinds of difficult services than any other type of valves. You find them in virtually all types of industrial process lines.

Why?

Because, with the original Nordstrom internal lubrication system they seal tighter, open more easily under pressure, let flow straight through, and have no gas—or fluid catching pockets to start corrosion or erosion.

Nordstrom valves and Nordstrom service are available by distributors everywhere. Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.



Rockwell | **Built**
Another Rockwell Product | **Nordstrom Valves**
LUBRICANT SEALED TO KEEP UPKEEP DOWN

Type 1551-A
Sound-Level Meter . . . $360

Industrial Noise Measurements *are made*

PORTABLE — *completely self-contained, small and compact*

VERY WIDE RANGE — *24 db to 140 db*

MEETS ALL STANDARDS *of the American Standards Association, the A.I.E.E. and the Acoustical Society of America*

SIMPLE TO OPERATE — *non-technical personnel can make accurate measurements*

EXCELLENT STABILITY — *improved negative feedback circuit provides flat frequency response from 20 cycles to 20 kilocycles*

EXCELLENT ACCURACY — *when amplifier sensitivity is standardized, absolute accuracy of measurement is within 1 db for average machinery noises*

TWO-SPEED INDICATING METER — *for steady or rapidly fluctuating sounds*

INTERNAL CALIBRATING CIRCUIT — *amplifier sensitivity can be standardized at any time from a 115-volt a-c line*

LOW TEMPERATURE and HUMIDITY EFFECTS — *readings independent of both under normal conditions (within 1 db)*

NON-DIRECTIONAL CRYSTAL MICROPHONE

SEPARATE OUTPUT TERMINALS — *jack terminal for output up to 1 volt across 20,000 ohms for use with analyzers, graphic level recorder or magnetic tape*

MANY ACCESSORIES AVAILABLE — *a-c operated power supply for long-time operation; special microphones for high fidelity measurements, for reproducible standards and for use at end of long cable; Octave-Band Noise Analyzer for use with the Type 1551-A Sound-Level Meter for simple and rapid analysis of noise with complex spectrum; Sound-Level Calibrator for making over-all acoustic check of complete instrument; Vibration Pickup and Control Box for vibration measurements down to 20 cycles.*

GENERAL RADIO Company
275 Massachusetts Ave. Cambridge 39, Mass.
90 West St. NEW YORK 6 920 S. Michigan Ave. CHICAGO 5
1000 N. Seward St. LOS ANGELES 38

SIMPLY · ACCURATELY
CONVENIENTLY
with GR Sound-Level Equipment

To Assist in Controlling and Studying the Effects of Industrial Noise

To Protect Persons Working Near Noisy Equipment

To Improve Working Conditions of Office Personnel

To Assist in Design and Construction of Buildings Housing Noisy Machinery

To Improve Performance of Industrial Equipment and Household Appliances

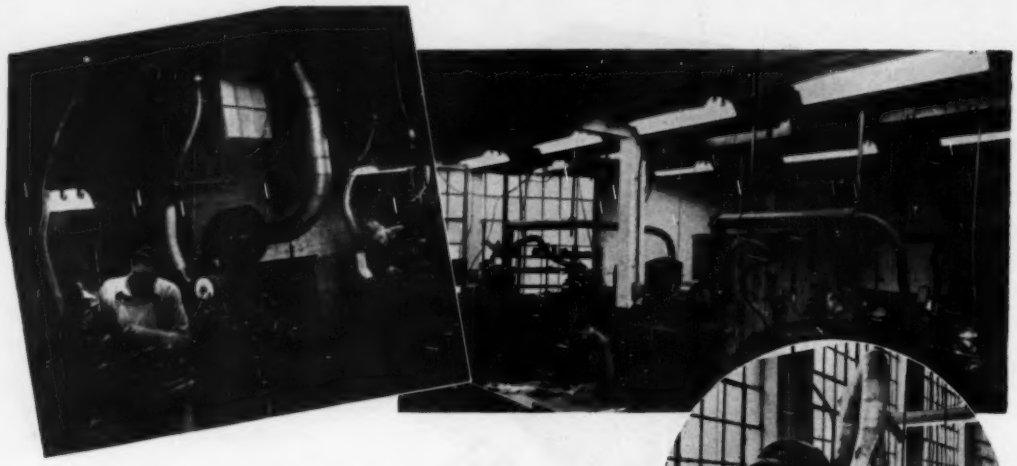
The new General Radio Type 1551-A Sound-Level Meter is very easy to handle. It weighs only 11 pounds, including its battery supply. It is simple to operate, requiring only switch selection of the appropriate response characteristic, and then the adjustment of a single attenuator switch until the meter stays on scale. The sound level is the sum of the attenuator and meter readings.

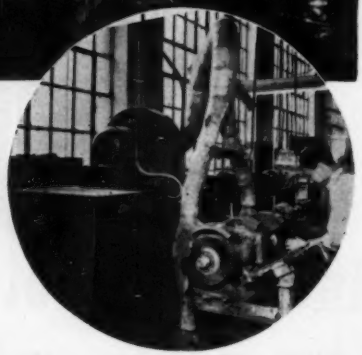
Please send me complete data on G-R Sound measuring Equipment. 545

Name _____

Address _____
Street

_____
City *Zone* *State*





Protect work and workers— control dust with

Norblo

high efficiency portable bag type *Dust Collection Units*

Any dust creating process, however small or intermittent, should be controlled if you want to avoid conditions that impair efficiency and endanger the health and safety of employees. Many plants can be effectively equipped with Norblo Portable and Semi-Portable Dust Collection Units *selected to fit the need.* They give you localized dust control for grinding, polishing, sawing and other operations at much lower cost than is possible with a large centralized system. Moving these units is no chore when plant rearrangement is necessary.

These Norblo bag type *portable* units occupy small space (maximum 4′ x 2′ floor plan); can be elevated to save floor area. Six sizes, covering a range of 300 to 1350 C.F.M., all operate at 8″ static pressure at the fan, complying with all industrial codes. Units are available in three arrangements for dust clean out—through door, hopper or drawer . . . Norblo *Semi-Portable* units are used where required capacities are greater than 1350 C.F.M. but less than that of usual large scale installations.

Norblo units are unusually quiet—are sturdily built for long service and low upkeep. Write for Bulletin 163-5.

THE NORTHERN BLOWER COMPANY

Engineered Dust Collection Systems for All Industries

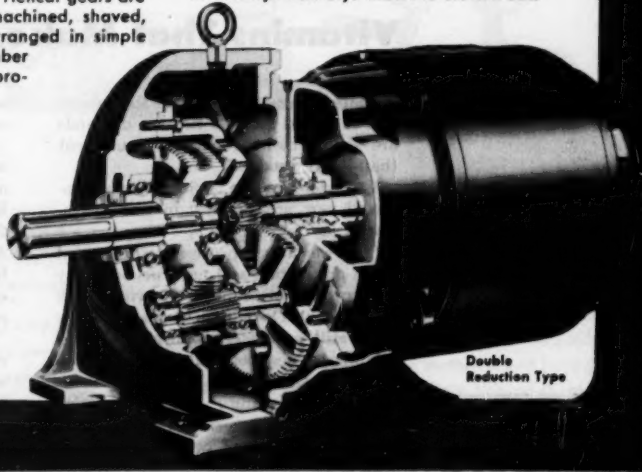
6421 BARBERTON AVE. • CLEVELAND 2, OHIO

9 POINTS

PHILADELPHIA GEARMOTOR

1. **Compact.** Designed to conserve greatest space without sacrificing strength or accessibility.
2. **Simplified Assembly.** Motor and gear unit each self-contained and readily separated. In multi-reduction units, gears may be inspected without disconnecting unit from driven machine.
3. **Balanced for Strength.** Gear unit designed to provide high operating stability.
4. **Quiet, Long-life Gears.** Helical gears are alloy steel, precision machined, shaved, wear hardened and arranged in simple train to minimize number of moving parts and promote quiet operation.
5. **Bearings.** Anti-friction bearings used throughout.
6. **Motors.** Reliance Precision-Built A-c or D-c Motors provide dependable power.
7. **Positive Lubrication.** Splash system with large oil reservoir assures constant lubrication and cooling of all parts.
8. **Standardized Construction.** Interchangeable stock parts simplify assembly and maintenance.
9. **Prompt Delivery.** Most Motors in stock.

For fast application of electric drives to individual machines the Philadelphia GearMotoR offers economical, efficient and dependable performance. They are available in single, double and triple reductions with a wide range of speeds: 780 through 7.5 r.p.m. Motor ratings from 1 h.p. through 60 h.p. For full details write on your business letterhead for Catalogue GM-48.



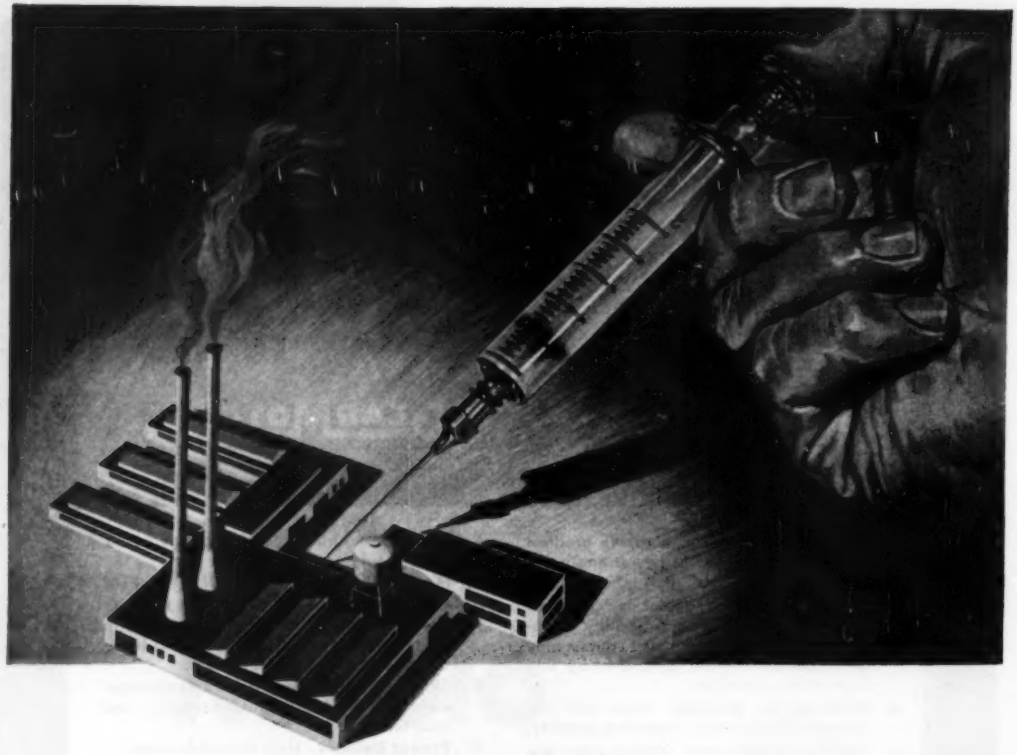
Double Reduction Type

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls



Vitamins That Make Production Grow

Perhaps, like many producers these days, you've found today's heavier demands are asking more from your equipment than it can produce.

Consider how one typical company injected new productivity into *its* operation:

This was a soap processor who needed extra production and new fuel economy for a process involving crude with a high salt content. Development of a specially-built still pot of economical clad steel eliminated need of multiple distillation . . . reduced fuel and maintenance . . . speeded up heating . . . ended corrosion . . . provided structural strength to withstand vacuum—*and cut first equipment cost, too.*

What makes this story significant is that it resulted from a progressive planning method followed by certain Equipment Builders.

These specialists bring leading engineers, designers, and materials suppliers into the planning of your equipment. Each factor affecting performance *is thought out by a specialist in that field.* And in such planning, you'll find these builders turning to Lukens for its knowledge of materials, as well as its wide range of low-cost clad steels.

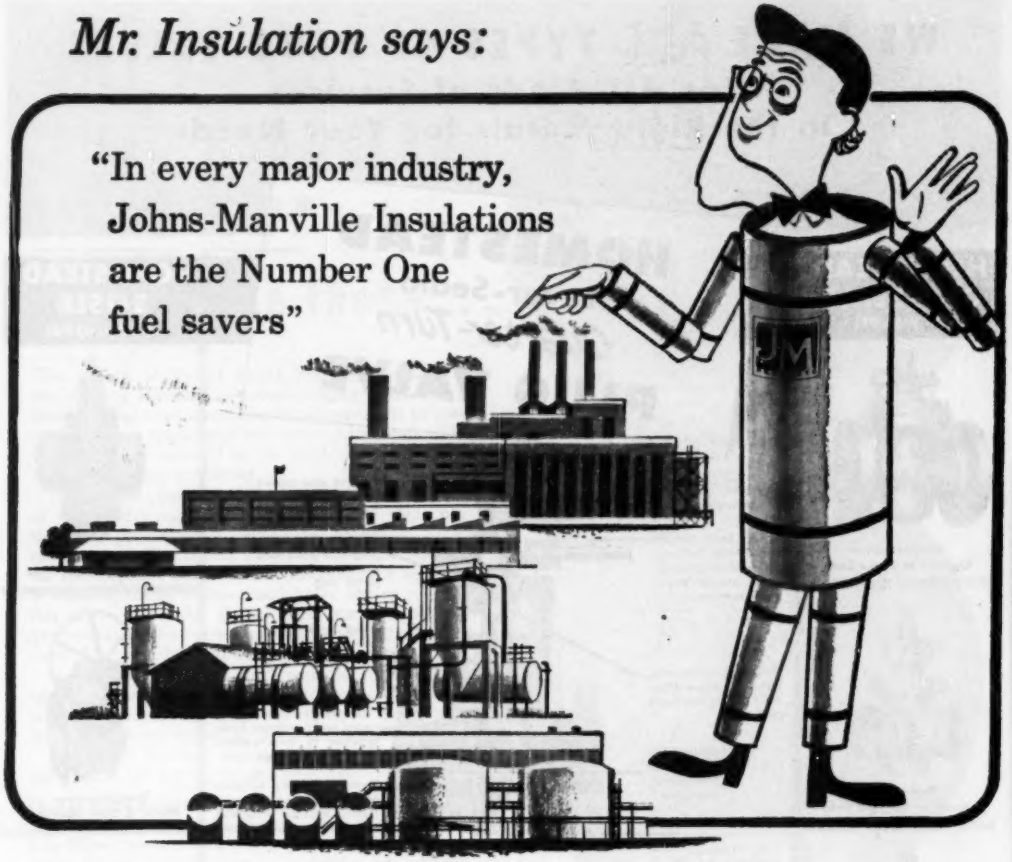
Even with new equipment often difficult to get these days, we know builders who can recondition what you have for better performance, better profits. Write us today, explaining your need. Manager, Marketing Service, 402 Lukens Building, Coatesville, Pennsylvania.

LUKENS

LUKENS STEEL COMPANY

WORLD'S LEADING PRODUCER OF SPECIALTY PLATE • PLATE SHAPES • HEADS • CLAD STEELS

Mr. Insulation says:



IN PLANTS with stacks or stills, tanks or towers, the story is the same—"Insulation by Johns-Manville" means the maximum return on your investment. There are two good reasons for this:

1. YOU GET THE RIGHT *MATERIALS*—From asbestos and other selected raw materials, Johns-Manville manufactures a wide range of industrial insulations for service from 400F below zero to 3000F above. If you need engineering advice in determining exactly the right one for your job, you can get experienced and authoritative assistance from your local Johns-Manville insulation engineer.

2. YOU GET THE RIGHT *APPLICATION*—Even correctly selected insulation needs proper application to permit it to serve at peak efficiency through the years. Here you can always count on J-M Insulation Contractors and their highly skilled mechanics. These organizations are trained in Johns-Manville application methods, and have generations of insulation experience behind them.

Why not get the complete picture? Call on insulation headquarters when your next job is in the planning stage. Just write Johns-Manville, Box 60, New York 16, N. Y.

JM

Johns-Manville *first in* **INSULATIONS**

WE MAKE ALL TYPES OF PLUG VALVES

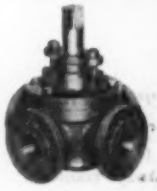
For *ALL* Kinds of Services
In the Right Metals for Your Needs

HOMESTEAD Lever-Seald *Quarter-Turn* PLUG VALVE

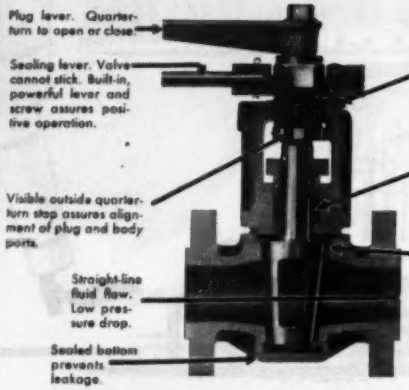
HOMESTEAD CAM-SEALD (dry seat)

Straight-way—
Flanged or Screw Ends

Three-way—
Screw or Flanged Ends



Four-way—
Flanged or Screw Ends


Plug lever. Quarter-turn to open or close.
Sealing lever. Valve cannot stick. Built-in, powerful lever and screw assures positive operation.
Visible outside quarter-turn stop assures alignment of plug and body ports.
Straight-line fluid flow. Low pressure drop.
Sealed bottom prevents leakage.
Positive stop allows seating pressure to be relieved only enough to overcome friction between plug and body and permit easy turning of the plug.
Deep stuffing box and gland. No leakage
"Lever-seald" action presses mated metal surfaces firmly together to form perfect seal against leakage.
Protected seating surfaces. No fluid or grit passes across seating surfaces. Maximum valve life and lowest cost-per-year service.

Sectional View — Homestead Lever-Seald Valve — Closed Position

Straight-way— Flanged or Screw Ends

Three-way— Flanged or Screw Ends

Four-way— Flanged or Screw Ends

HOMESTEAD-REISER (lubricated)

Straight-way—
Screw or Flanged Ends

Straight-way—
Worm & Gear Operated

Flow Changer—
Non-lubricated

You can end valve-operating difficulties on high temperature, pressure and corrosive services, and on jobs where lubricant would contaminate process fluids, by installing Homestead Lever-Seald Valves. They are stick-proof, because a *built-in* lever and screw device assures positive action at all times, under all conditions. If the service warrants, they may be double-sealed by pressure gun lubrication.

Homestead Lever-Seald Valves are available in straight-way, three-way, and four-way types, with screwed or flanged connections. They may be cast in Semi-Steel, Steel, Ni-Resist, Stainless Steel, Monel, or other alloys; in sizes from 1" to 10"; for vacuum to 1500 lbs., and for temperatures from 40° below zero to 1100°F. For full information, write for Valve Reference Book No. 39-3. No obligation.

Distributors in all parts of the world. For local representative see Classified Telephone Directory.

HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. BOX 38 "Serving Since 1892" **CORAOPOLIS, PA.**

WHY FARREL SPEED REDUCERS *STAND OUT* on jobs like these...

The design of Farrel speed reducers permits an engineering freedom in proportioning gears, shafts, bearings and even some housing dimensions to meet specific load, speed and service requirements. This flexibility has resulted in the solution of innumerable application problems.

In addition, Farrel speed reducers have a number of other advantages which account for their outstanding performance record in handling tough assignments. The quiet, vibration-free operation of the herringbone gears results from extreme accuracy of tooth spacing, contour and helix angle... qualities inherent in the Farrel-Sykes method of gear generation. Precision manufacture and highest grade materials contribute to long gear life.

Shafts and bearings are factored to safeguard against interruption of vital processes. Gear cases are proportioned to withstand repeated heavy peak loads. Joints are sealed to prevent entrance of dirt.

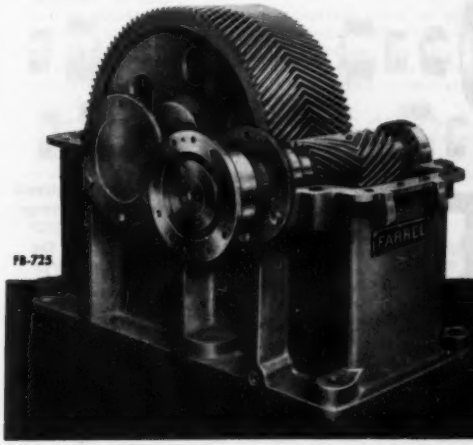
Write for further details of these outstanding units. Ask for a copy of Bulletin 449.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

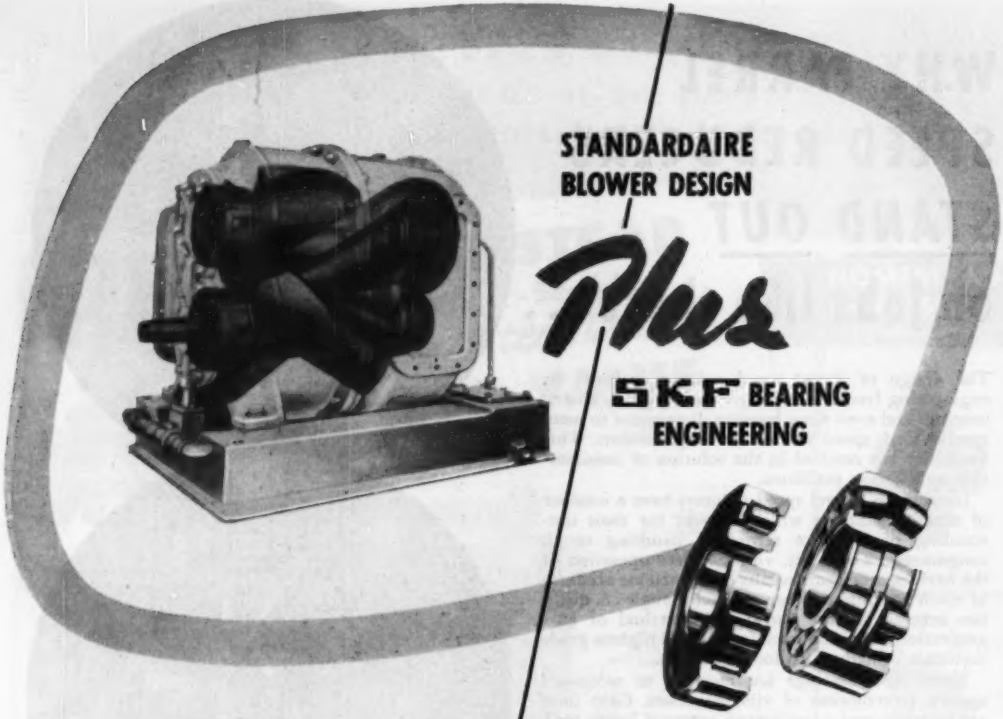
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Detroit, Chicago, Portland (Oregon), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

Farrel-Birmingham®



FB-725

Two single reduction units driving a skip hoist
Single reduction unit driving a rolling mill
Double reduction unit driving rotary kiln in cement mill



STANDARDAIRE BLOWER DESIGN

Plus

SKF BEARING ENGINEERING

Every so often, a manufacturer has a chance to *prove* his wisdom in the selection of the product components he specifies.

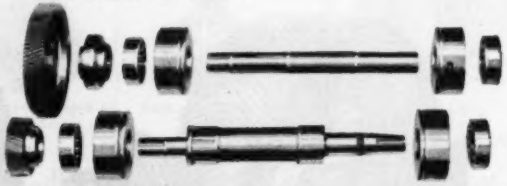
For example, Read Standard Corporation was able to obtain performance data on one of their "Standardaire" Blowers which had operated 24 hours a day, for 15 months, at 2200 rpm.

In other figures, that's about one and a half billion revolutions—representing many years' service for typical blower installations.

Even after the hard, difficult service, this blower and bearings were found to be in excellent condition when dismantled and inspected in the presence of Read Standard customer's representative.

Performance like this is proof of sound *design*—proof, too, that the designers selected the best available materials and component parts . . . among these were SKF Bearings.

Here we quote from the "Standardaire" Blower performance report: "Anti-friction bearings in good condition." They were SKF Cylindrical, and Spherical Roller Bearings, designed into the gate rotor shaft and main rotor shaft as shown in the illustration.

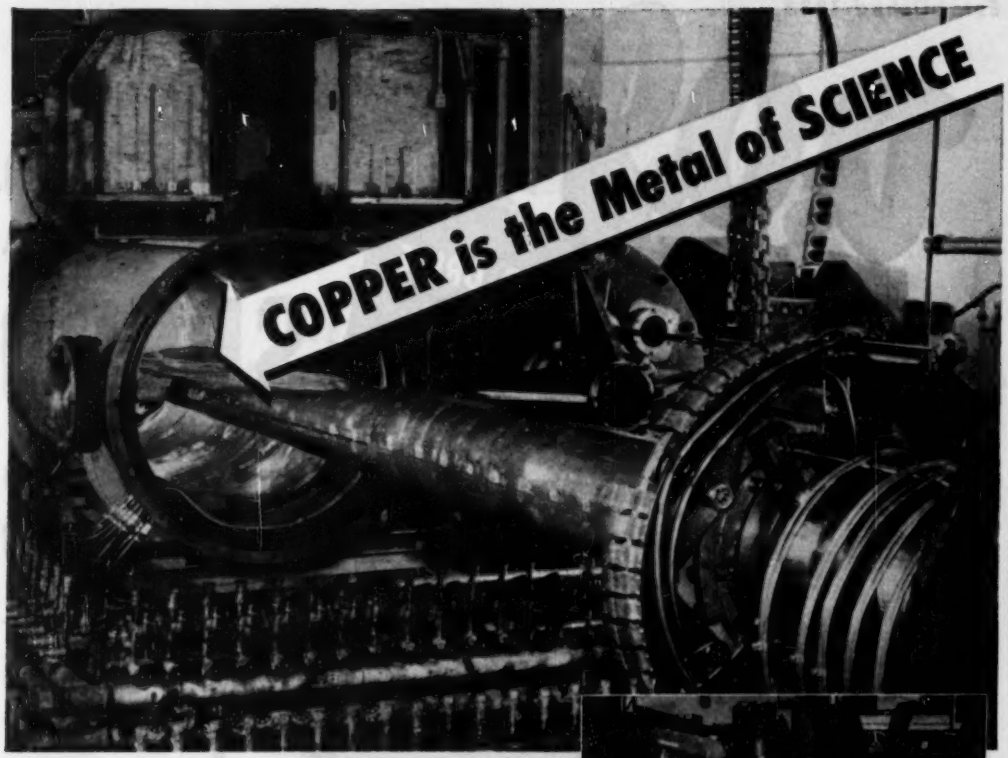


SKF
BALL AND ROLLER BEARINGS

IN EVERY INDUSTRY, SKF Puts The Right Bearing In The Right Place

Remember—if you want design assistance and engineering help when you're laying-in bearings, you can get it from SKF field or home office men who know the best ways to do the job in every industry. **SKF INDUSTRIES, INC.,** PHILADELPHIA 32, PA.—*manufacturers of* SKF *and* HESS-BRIGHT *bearings.*

7323



D and D Stem being inserted in Cyclotron; made of Revere Electrolytic high-conductivity copper, hot rolled and annealed, ½" thick. Note also large number of bronze valves to control flow of cooling water through brass pipe.

● For many years Revere has been saying that "Copper is the metal of invention." It has high electrical and heat conductivity, excellent resistance to corrosion, is easily fabricated and formed, so that it is attractive to designers and inventors, as well as to manufacturers. Now we say it is also "The metal of science," because it is so essential to the operation of most scientific devices.

The pictures on this page illustrate some of its uses in a cyclotron, built by and for the Nuclear Physics Laboratory of the University of Washington in Seattle. The instrument was designed and constructed so far as possible by University personnel, who were completely successful in working copper into the most complicated shapes.

Revere collaborated on the project in various ways, and furnished copper bar, sheet, rod and tube to the University's high specifications. Remember that Revere will be glad to consult with you on your problems concerning copper and copper alloys, and aluminum alloys.

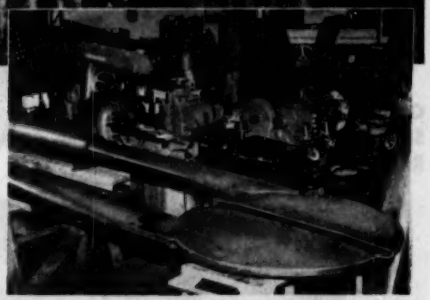
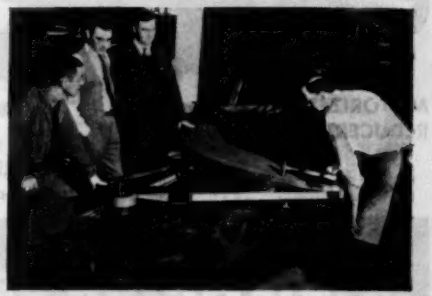


Photo taken in the University of Washington shop during fabrication of the two Ds and D Stems.



Seven miles of Revere copper bus bar were wound into great coils for the cyclotron electromagnet. The University built the winding machine itself, and wound the coils in its own shop. The special Revere bar is soft temper, free from scale, with rounded edges.

REVERE 150th YEAR OF SERVICE TO AMERICA

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

Established 1888

D.O.James

CENTRALLY DRIVEN BALANCED DRIVE
With Great Emergency Strength

GEAR SPEED REDUCERS

Multiple tooth engagement, low tooth stresses, with high load capacity and high wear factor. Gears are heat treated, shaved and crowned (Elliptoid), equally balanced and revolving in same direction, quiet operation, long gear life, and highest efficiency.

Catalogs are available containing complete engineering data.

D.O.JAMES GEAR MANUFACTURING CO.
1140 WEST MONROE STREET • CHICAGO 7, ILLINOIS

TERRY

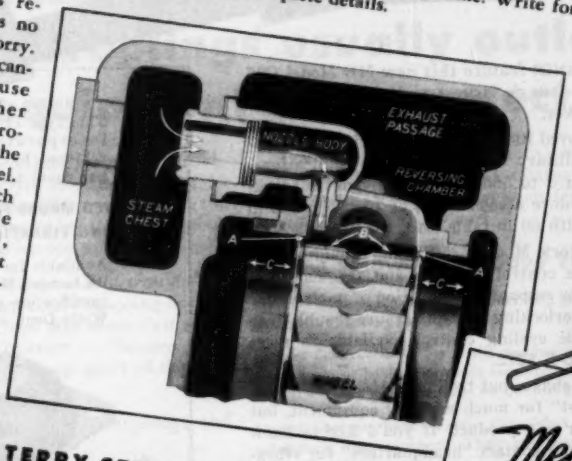
LARGE CLEARANCES take the "worry" out of Turbine Operation

In a Terry Solid-wheel Turbine the power-producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets. This unique design permits unusually large blade clearance—see B in the diagram.

Even if this clearance becomes reduced, there is no real cause for worry. The blades still cannot foul because they are further protected by projecting rims at the sides of the wheel. These rims, which also have ample clearances (AA), will take without damage any rubbing that may occur.

Side clearance, CC, is so large that end-play from external thrust will not damage the wheel. This clearance is one inch or even greater.

Large side and blade clearances are only two of the many features of the Terry Solid-wheel Turbine. Write for complete details.



THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1191

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

Put FORCE behind your vibration testing

...more than 2500 pounds of it with this big MB exciter

POWER AND ENDURANCE feature this new MB Model C25 Vibration Exciter – today's largest and most dependable electromagnetic shaker.

It has already proved its heavy-duty capacity in a number of important military vibration testing applications. In frequencies from 3 to 500 cps, it easily develops required forces to produce accelerations of 15g with 100 lb table load or 20g with 60 lb table load, for example.

Like all MB Exciters, Model C25 Shaker provides easy, accurate, continuous control of force and frequency. It allows "scanning" for response to vibration of parts under test. Electrically interlocking controls assure trouble-free operation. Automatic cycling control available to meet specifications of MIL-E-5272.

Vibration testing shakes out troubles before they start. It's not only a "must" for much military equipment, but also a good idea for *any* product. If you'd like to know more about it, why not contact "headquarters" for vibration engineering – MB! You'll find the help and advice you're seeking.

APPROVED MOUNT FOR ISOLATING VIBRATION

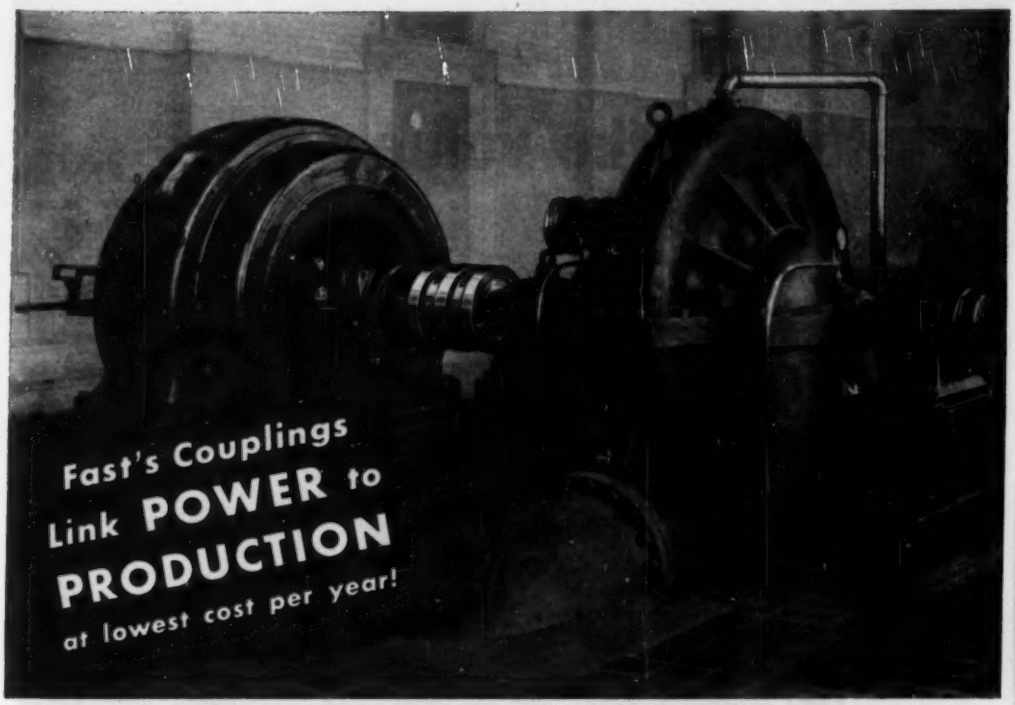
This Type 17 MB Vibration Isolator incorporates a principle first achieved by MB in mountings. It has equal spring rates in all directions in order to isolate all modes of motion with equal efficiency. Available for loads from 0.5 to 100 lbs to meet MIL-I-5432 (AN-I-16a) specification on vibration isolation. Write Dept. 4 for details.

MORE DETAILS

New bulletin containing specifications, operational information and helpful hints on usage, is now available on the complete line of MB Vibration Exciters which includes models from 10 lbs to 2500 lbs force output. Ask for Bulletin No. 1-VE-4.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION...TO MEASURE IT...TO REPRODUCE IT



FAST'S Couplings usually outlast the equipment they connect!

ACTUAL cases on record show many Fast's Couplings are still in service after as much as 30 years of continuous operation! Time and time again, equipment has been replaced while the original Fast's Coupling remained on the job.

To you, these records of dependable, trouble-free service mean freedom from costly coupling failures when you specify Fast's. And they mean Fast's cost you far less to own and operate . . . because their cost can be amortized over long years of dependable performance.

For full details on how Fast's Couplings and Koppers Engineering Service can help you, write today for a free copy of our catalog to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 256 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS® FAST'S THE ORIGINAL GEAR-TYPE Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,*
256 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

Company .....

Address .....

City ..... Zone ..... State .....

● THE MUNICIPAL ELECTRIC PLANT

of MUSCATINE, IOWA

Knows the value of

Automatic Control

Republic automatic boiler control and instrument panels at Muscatine Municipal Electric Plant

● In 1941 the Municipal Electric Plant at Muscatine, Iowa, installed a modern 100,000 lb. per hr. steam generator. In 1948 a second boiler rated at 160,000 lb. per hr., 650 psi. was added.

In any steam electric generating plant, electric power rates and steam costs go hand-in-hand. Low steam cost however, is not the result of efficient boiler design alone. To realize all the operating advantages of these modern boilers, each was equipped with a Republic automatic combustion and feed water control system at the time of installation.

The installation of Republic automatic controls on your boiler or (boilers) will enable you to:—

SAVE FUEL by automatically maintaining highest combustion efficiency.

INCREASE STEAM OUTPUT by operating the boilers at test efficiency 24 hours a day, 7 days a week.

CONSERVE MANPOWER by automatically performing the many routine repetitive adjustments.

REDUCE OUTAGES by maintaining uniform operating conditions.

Find out about Republic control systems. One of our engineers will be glad to consult with you at any time. Write us today.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

third control?

• Frequently you give serious thought and attention to *pressure* and *temperature control*. This is quite natural because it means better operation and more production and often prevents damage. But what about the *third control—entrainment control*. Lack of this control can be just as costly as lack of pressure and temperature control.

Lack of the third control can mean shut downs and loss of production due to entrainment wear in engines and process equipment. Larger slugs of entrainment have been known to blow off cylinder heads of reciprociting engines and to ruin thrust bearings of turbines.

Lack of third control means poor efficiency of superheaters, steam ejectors, dryers and other equipment. It means dirty pipe lines and fouled valves.

End this damage *once and for all* with Hi-eF Purifiers. They remove 99% of all entrainment. Individually guaranteed, Hi-eF Purifiers are the most economical protection you can buy . . . they cost no more than an ordinary separator. Write us today about your entrainment problem. Let our engineering staff, without the slightest obligation, give you the proper solution.

PURIFIER DIVISION,

THE V. D. ANDERSON COMPANY

1975 West 96th Street • Cleveland 2, Ohio

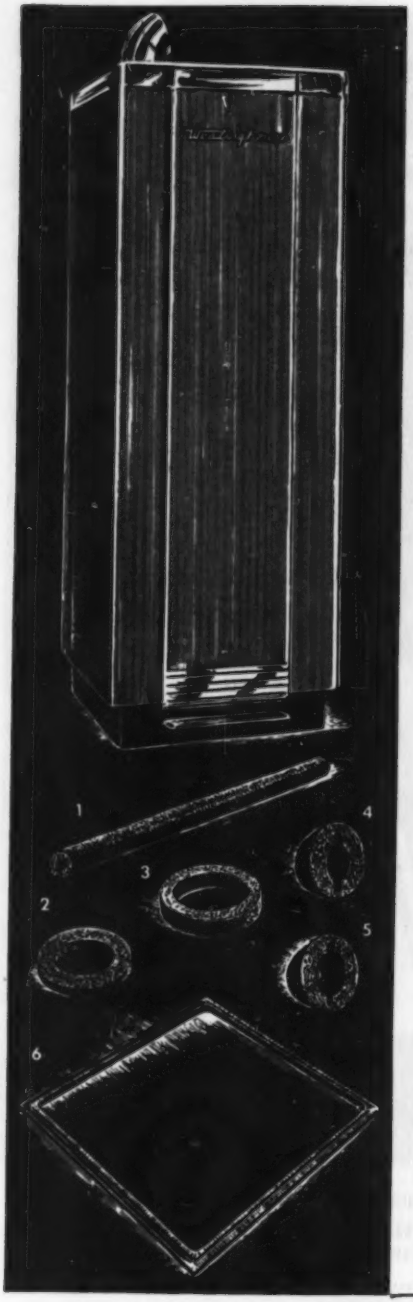
Gentlemen: Please send additional information on Anderson Hi-eF Purifiers.

Name.....

Company.....

Address.....

City.....**Zone**...**State**.....



Westinghouse Water Cooler
gives longer, better service with
SPONGEX Cellular Rubber

Corrosion . . . deterioration . . . mechanical failure . . . repairs and parts replacement—an inevitable sequence wherever moisture condensation collects. It's a problem particularly troublesome in refrigerating equipment—but not in this Westinghouse water cooler!

Westinghouse has given its cooler a wardrobe of Spongex cellular rubber. Exposed cold surfaces—tubing, valves, even the waste water drain—are covered by custom molded Spongex parts. These Spongex parts not only prevent condensation but their insulating qualities increase refrigerating efficiency. For this cooler, Spongex means a longer, better, more efficient life.

The Westinghouse Wardrobe of SPONGEX

1. Tube insulator—
covers cold water tubing that supplies the drinking bubbler.

2. Basin drain seal—
forms a water tight seal between bottom of the water cooler basin and top of the drain. The compressibility of Spongex compensates for variations in the clearance between basin and drain.

3. Basin drain insulator—
covers exposed end of the waste water drain.

4. Regulatcr valve cap—
covers the cold surfaces of valve. Elasticity and flexibility of cap makes it easily removed for valve adjustment.

5. Water valve cap—
covers shut off valve controlling water flow to bubbler.

6. Door gasket—
forms an air tight seal for the door opening into the cold storage compartment. The gasket also seals off the insulating air space between the inner and outer panels of the door.

Perhaps Spongex can help better your product, too. We would be happy to hear from you.

SPONGEX® Cellular Rubber

used for cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

THE SPONGE RUBBER PRODUCTS COMPANY 501 Derby Place, Shelton, Conn.

Now... closer temperature approaches in heat exchange

WITH TRANE BRAZED ALUMINUM SURFACE

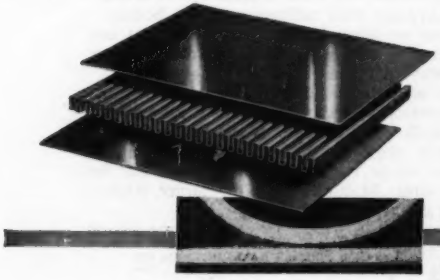
Now . . . even with a large temperature change or drop . . . you can obtain *temperature approaches of 5° to 10° F.*

TRANE Brazed Aluminum heat exchange surface makes it not only possible—but *practical!* That's because the new TRANE Brazed Aluminum packs up to 450 square feet of surface into a single cubic foot of space.

This huge amount of surface in a single unit makes maximum use of available pressure drop. And you don't lose pressure through connections.

TRANE Brazed Aluminum can handle heat transfer between three, four, five or more streams simultaneously —liquid to liquid, liquid to gas, or gas to gas. Temperatures from 500° F. to –300° F. Tested at pressures up to 1000 Psig.

Want more information? Contact your nearest TRANE sales office, or write The TRANE Company, LaCrosse, Wis.



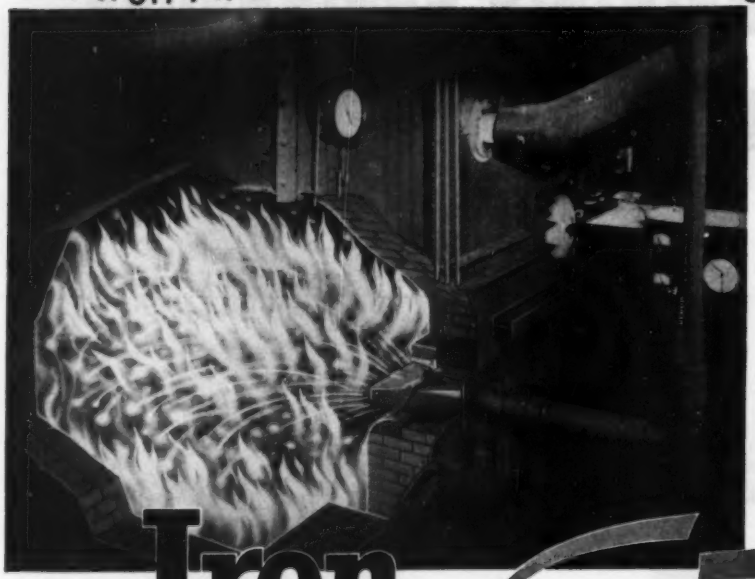
WHAT IS BRAZED ALUMINUM? A stack of flat plates and corrugated fins in layers, all brazed in perfect bond. Strong, light, compact and completely flexible. Illustration below shows strong fillet formed between fin and plate.

MANUFACTURING ENGINEERS OF HEATING, VENTILATING, AIR CONDITIONING AND HEAT TRANSFER EQUIPMENT

TRANE

THE TRANE COMPANY, LA CROSSE, WIS.
Eastern Mfg. Division, Scranton, Pa.
Trane Company of Canada, Ltd., Toronto
Offices in 80 U.S. and 14 Canadian Cities

We saved 33.9% on fuel alone with this Iron Fireman method of coal firing



Mr. H. A. Quinn
Manager Toledo Laundry

Here's the Record

Fuel costs down 33.9%

Steam processing temperature up 5%

Average CO_2, 12.9%

Boiler pressure, 125 PSI

Average stack temperature, 452° F.

Iron Fireman

PNEUMATIC SPREADER STOKERS

A COMPLETE COAL DRYING, CONVEYING, DISTRIBUTION AND COMBUSTION SYSTEM. Coal is thoroughly dried and pre-heated and is conveyed pneumatically to furnace grates. Dry coal assures far more uniform distribution over *entire* grate in shallow, uniform fuel bed. Pre-heated fines burn in suspension, reducing cinder carry-over and greatly improving combustion efficiency and responsiveness as compared with stokers which do not pre-heat coal.

Fuel savings, plus labor savings resulting from automatic conveying, plus the stoker's ability to follow a fluctuating load—these are the reasons given by Mr. Quinn for installing the Iron Fireman Pneumatic Spreader at the Toledo Laundry after several years' experience with similar Iron Fireman equipment in the company's two other plants.

No other stoker combines the many exclusive features and money-saving extras of the Iron Fireman Pneumatic Spreader stoker. Manual coal handling is completely eliminated—and without extra cost, because the automatic coal conveying system is part of the stoker itself. So flexible is this conveying system that coal bunkers can be located almost anyplace with reference to the boilers—back, front or sides. In one installation that has been operating for years coal is fed from bunkers 32 feet below the firing floor.

Fully modulated fuel feed and air volume are automatically synchronized. Air supply is kept in step with coal feed-rate at all times. Coal is thoroughly pre-dried for uniform distribution. Capacities range to 1,000 boiler horsepower for a single unit. Multiple units for larger boilers. Send for descriptive literature.

Coal, Gas, Oil firing equipment for heating, processing, power

WRITE FOR CATALOG

IRON FIREMAN MANUFACTURING CO.
3260 West 106th Street, Cleveland 11, Ohio.

Send me literature on the Iron Fireman Pneumatic Spreader Stoker.

Name_____

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City_____ State_____

Farval solves the lubrication problem on Automatic Shears

AUTOMATIC flattening and cutting machines in steel mill service get rough treatment. There are always scale and dirt in the air. To keep dirt out of bearings, enough oil is used to insure its working out of the bearing ends. In most mills, machines are worked round the clock, so there is no time to lubricate without shutting down. Continued use without proper oiling guarantees trouble.

To insure adequate, continuous lubrication, The Hallden Machine Company depends on Farval Centralized Lubrication. In fact, it has been standard practice with Hallden to install Farval on every machine it has built in the past 25 years. They believe this is the surest way to keep their machines functioning smoothly.

Farval accomplishes correct bearing lubrication while machines are in operation, without disturbing production schedules. Result: No slow downs, no breakdowns, no down time for repairs due to faulty oiling.

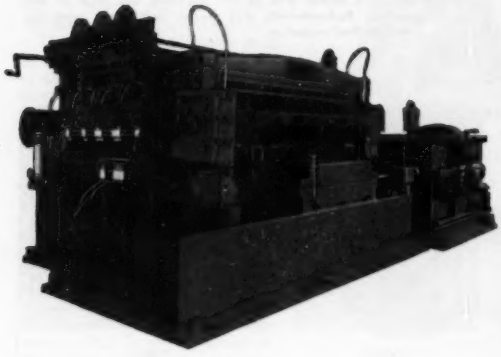
Farval is the original Dualine system of centralized lubrication for industrial equipment, proved practical in 25 years of service. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, the Farval system unfailingly delivers oil or grease to each bearing—as much as you want, exactly measured—as often as desired. Indicators at all bearings show that each valve has functioned.

In or near your city there's a Farval engineer, ready to discuss your lubrication problems and suggest a proper system to meet your particular needs.

The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

FARVAL—*Studies in Centralized Lubrication*
No. 128



KEYS TO ADEQUATE LUBRICATION—*Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine will be properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.*

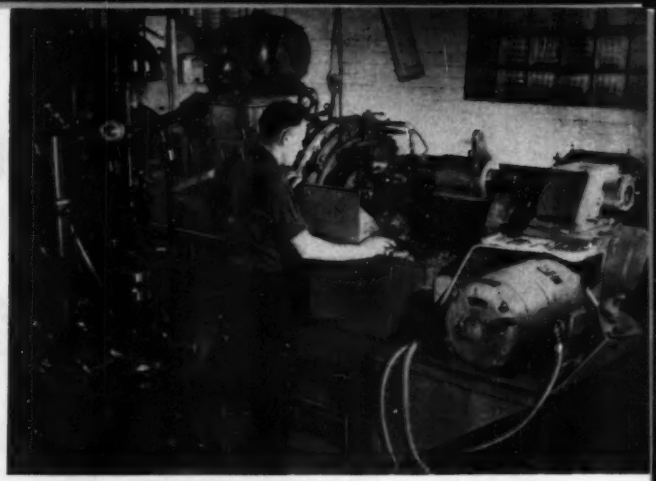
Photo by courtesy The Hallden Machine Company.

valve values
PHOTO NEWS

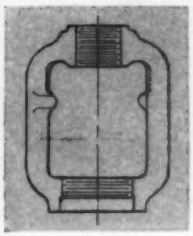
Edward Builds Valve Performance

THROUGH EXCLUSIVE SHOP PROCESSING

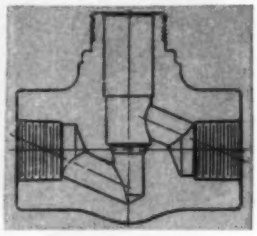
Today's turbines, boilers, refinery cracking units, and chemical apparatus are major equipment items that operate continuously for long periods with great reliability. Poorly made valves can cause expensive shutdowns of large investments. Edward's know-how in building steel valves dates from 1904. Costly special machinery in the Edward plant is designed to make valve parts which insure long, trouble-free service. Illustrated are two machines, exclusive with Edward, designed to process strong, drop forged parts with perfect alignment and concentricity, plus fine finishes and tolerances. Add top-notch shop men—then Edward users get the best in plus-value valves.



A unique and exclusive Edward machine tool, combining the best features of Baird, Goss-DeLeeuw, and Edward designs, makes small valve bodies with perfect alignment and finish in one operation. Rockwell-Delta drill presses (left) finish parts for immediate final inspection.

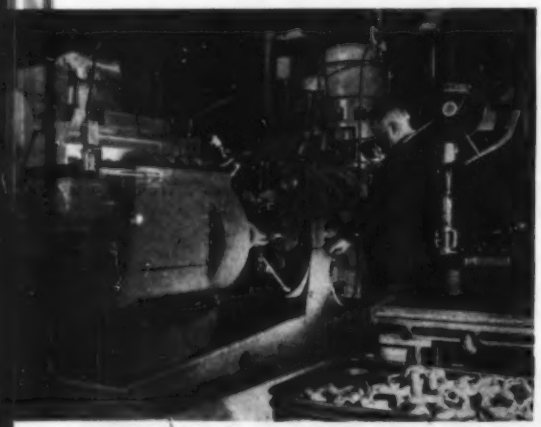


YOKE



BODY

The valve yoke and body *above* look simple, but require the high priced tools illustrated. Every part must be in perfect alignment. By doing the machine operations on such parts in one set-up, valves will go together just right. On the yoke (*left*) both threads are made in one operation. All bonnet-end operations of the drop forged valve body are finished in one set-up.



Exclusive tooling on this "work-rotating chucker" finishes both ends of forged valve yokes simultaneously. One machining operation does the entire job, insuring precision alignment of valve yoke bushings, stems, disks, packing glands, and backseats.

Special gages check alignment of Edward Fig. 952 yoke immediately after making.

The finished valve parts go together perfectly.

Edward Valves, Inc.

Another Rockwell Product

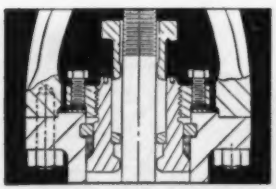
New Edward PRESSURE-SEAL* Bonnet Construction

The successful use of pressure seal bonnet valves during recent years has brought to light some problems in the design in smaller sizes. The valve designer, faced with fitting into the bonnet bore a stem, bonnet, pressure sealing gasket, spacer ring, retainer ring, packing chamber, and gasket loading mechanism, found some sacrifices would have to be made unless cost and valve dimensions could be ignored.

The first solution consisted of a large lugged nut gasket pull-up, screwed on to the bonnet and bearing on the top of the yoke base or the retainer ring, so that turning the nut pulled the bonnet upward and deformed the gasket.

This construction (never used by Edward) was found difficult to use in the field. The large diameter threading on the lugged nut, together with the broad bearing surface of the nut, made it difficult to accurately determine the load being applied to the gasket even under favorable conditions. Further, because of moisture in the packing chamber area, the loading mechanism threads frequently corroded badly, making adjustment difficult and service performance more in doubt.

In the smaller sizes, internal pressure provides only part of the load required for gasket deformation. Consequently, positive mechanical loading is even more important than in large valves. Believing that uniform and accurate loading of the gasket is vital to satisfactory performance of all pressure sealed bonnet valves, Edward has provided additional space in 5 in. and smaller PRESSURE-SEAL* valves by using a yoke outside the normal position.



An exclusive Edward design

Illustrated is a 4 in. 900 lb Edward PRESSURE-SEAL* globe valve so constructed. Note this permits the use of four small readily accessible, individually loaded studs resting on a hardened bearing plate on top of the valve body. Torque may be applied accurately to each of the four pull-up studs, and the gasket loading uniformly distributed around the gasket contact area circumference. See cross-section view. All Edward PRESSURE-SEAL* valves have high gasket loading with low individual torque load on the pull-up studs. In addition, they have exclusive features such as scientifically streamlined bodies, integral Stellited seats, and Impactor handwheels as standard construction.

*TRADE MARK REG.

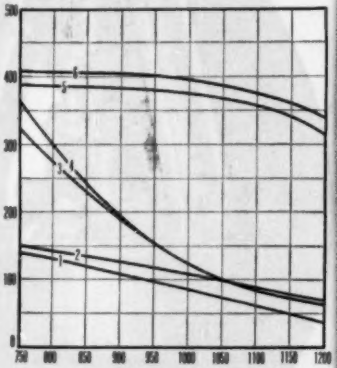
EDWARD VALVES, Inc., *Subsidiary of*
ROCKWELL MANUFACTURING COMPANY
1350 W. 145th ST., EAST CHICAGO, INDIANA

GLOBE AND ANGLE STOP • FEED-LINE • BLOW-OFF • NON-RETURN CHECK • GATE • GAGE AND INSTRUMENT • RELIEF • STRAINERS

Technical Tips

What Heat Does to Valve Trim Hardness

Valve "trim" refers to working parts such as seats, disks and wedges, in contact with line fluid. Hardness, usually expressed as "Brinell" or "Rockwell" is an important requirement in temperature and erosion services. Ability to retain room temperature hardness largely determines valve trim life in many services above 800 F. Chart below shows what continued heating does to hardness of several trim alloys. Base line hardnesses at 750 F approximates room temperature hardnesses for all these materials. Also charted, as a basis for comparison, are hardness-temperature curves for two common valve body materials.



HARDNESS AT TEMPERATURE OF VARIOUS VALVE MATERIALS

1. A.S.T.M. A216—WCB—Valve body material.
2. A.S.T.M. A217—WC6—Valve body material.
3. Edward EValloy—400 BHN—Valve trim material.
4. Type 420—500 BHN—Valve trim, material.
5. Hastelloy 21—Heat treated, valve trim material.
6. Stellite No. 6—Valve trim material.

• • •

Edward EValloy, a 400 Brinell, low carbon high strength 13 per cent chromium stainless, employed by Edward since 1921, and the Type 420 (more brittle and slightly less corrosion resistant) high carbon, 13-16 per cent chromium stainless steels lose hardness rapidly above 750 F.

For toughness at higher temperatures, Stellite, a cobalt-chromium-tungsten alloy, and Hastelloy, a cobalt-chromium-molybdenum alloy hold hardness well to 1200 F, and are ideal for erosive throttling services at all temperatures. Of the two, Stellite is the more widely used for valve seating surfaces. Both have good corrosion resistance.

Monel metal, a copper-nickel alloy, and "18-8" chromium-nickel alloys lack high hardness needed for temperature and erosion resistance, but serve well in many corrosive services.

Edward

STOP VALVE LEAKAGE IN YOUR HIGH PRESSURE STEAM AND BOILER FEED LINES

Lunkenheimer Breech Lock Valves are built to control steam and water at high pressures and temperatures with absolute safety and freedom from leakage. The patented disc is flexible and resilient to assure tight seating and prevent sticking when in the closed position. The body and bonnet are locked together like the breech mechanism of a large gun. Internal pressure loads are carried by the inter-locking breech lugs, and the joint is made pressure tight by a seal weld. Gaskets, threaded rings and bolts are eliminated. The bonnet joint can be readily disassembled and reassembled.

WRITE FOR the address of your nearest Lunkenheimer representative, who will give you full details and make specific recommendations. The Lunkenheimer Co., Box 360E, Cincinnati 14, Ohio.

BREECH LOCK
1500 LBS. S.P.
STEEL GATE

STEEL • IRON BRONZE

L-451-4

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Aeronautical Electrical Mechanical

A New Opportunity, in a New Division, working for a top leader in commercial and military aviation.

A new joy in living, in famous North Georgia climate, only 8 miles from Atlanta, second highest large city in the U. S. 88 parks cover 1600 acres, and 22 excellent golf courses offer year-round enjoyment.

Atlanta and North Georgia are famous for their beautiful homes, and desirable, modern housing is available. Fine elementary and high schools, colleges and universities, plus vocational and professional schools serve the area. 10 radio and 3 television stations and more than 50 theatres bring in top entertainment. Best cultural advantages are offered, and 500 churches are affiliated with 40 creeds and denominations.

You will find a better life—a better future—at LOCKHEED.

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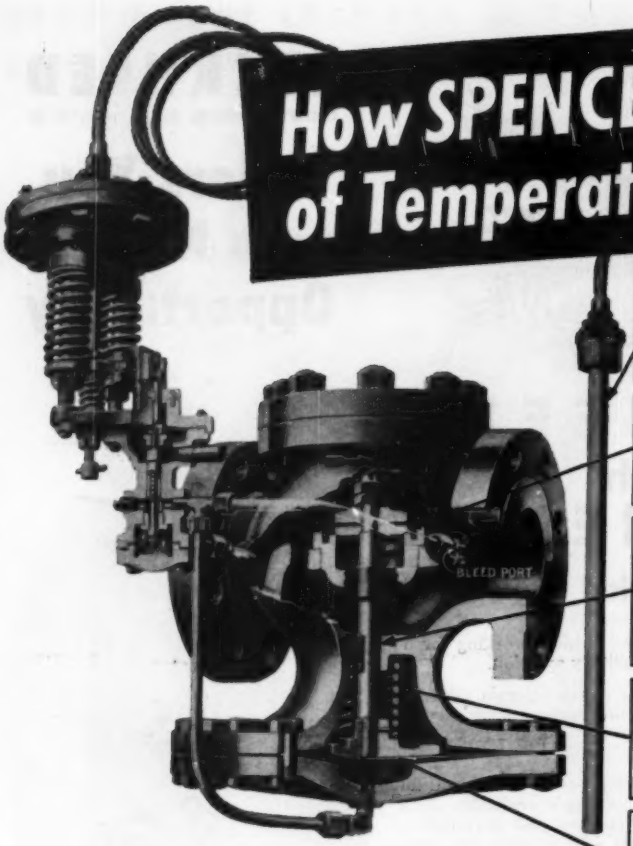
How SPENCE Cuts Costs of Temperature Control



NEW THERMOSTAT ELEMENT—Improved to practically eliminate loss of filling. Rugged construction; cannot be injured by overheating.

SECO METAL—Seats and discs are made of SECO Metal—guaranteed not to wire-draw.

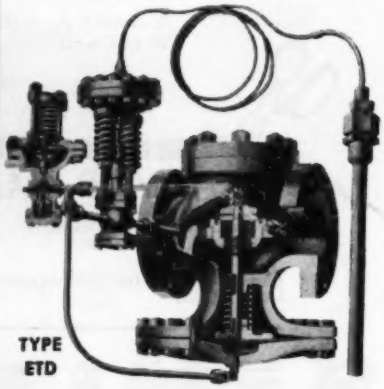
PACKLESS CONSTRUCTION — All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . eliminates much time-consuming maintenance.

PROTECTED SPRINGS — Springs in the Spence Regulator are out of the path of the steam or other fluid flowing through the valve.

LARGE BALANCED DIAPHRAGM— Spence metal diaphragms, under usual conditions, never require replacement.

Accurate Control for Both Storage and Instantaneous Heaters

Spence Temperature Regulators reduce the steam pressure and also accurately modulate the flow as required to control the temperature. No separate reducing valve is necessary • The Spence ET150 Regulator is recommended for heater pressures up to 50 psi. For higher pressures the Type ETD is available • For complete details on the entire Spence line of automatic regulating valves, strainers and desuperheaters, write for Bulletin 1200.



TYPE ETD

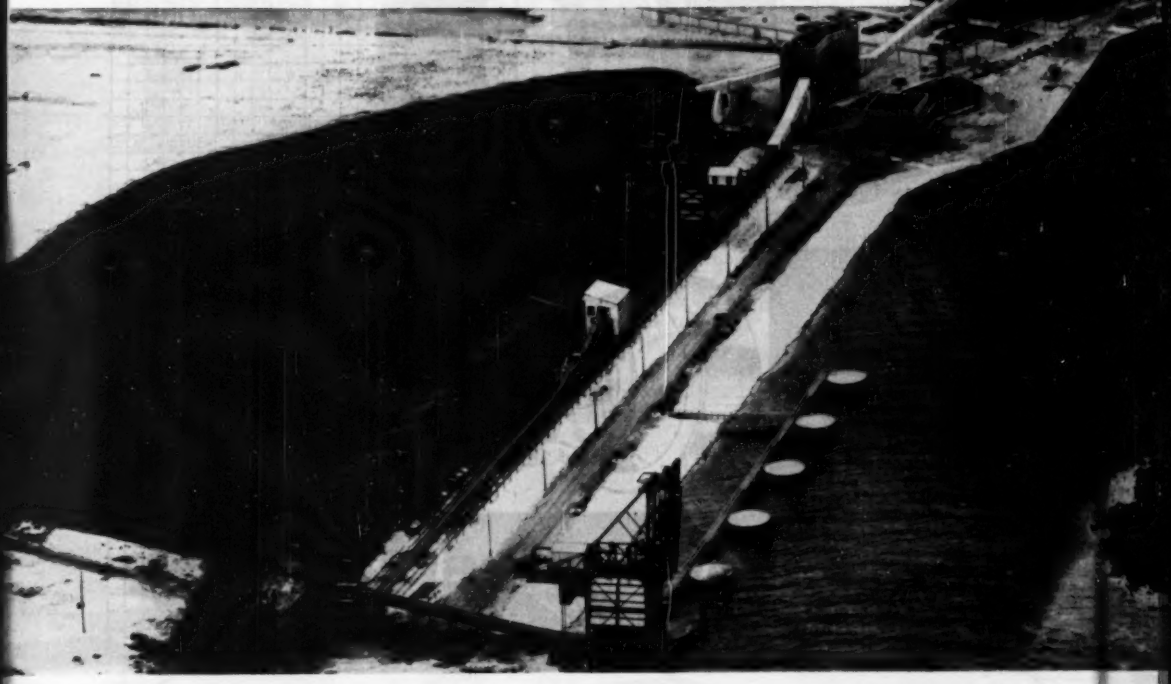
SM 111

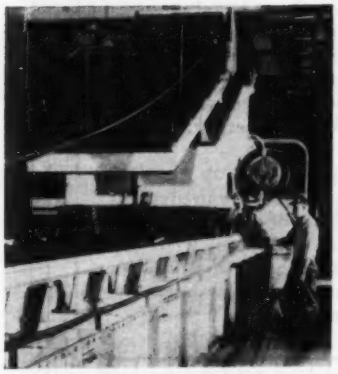
Spence

SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

LINK-BELT research and engineering . . . Working for Industry

Picture of what it takes to keep a power plant going





This flexible Link-Belt conveyor system at a modern generating station provides for selective handling, storage and reclaiming of coal unloaded from lake boats. Lower illustration shows belt conveyor and tripper distributing coal to bunkers.

LINK-BELT coal handling equipment plays a vital role in feeding America's hungry boilers

An efficient system of coal handling is basic in the design and economical operation of modern coal burning steam generating plants. Maximum efficiency and minimum costs are achieved only when the coal system is properly planned as an integral part of over-all plant design.

Link-Belt engineers have a vast background of experience in both large central station and smaller industrial coal handling applications. More, Link-Belt is prepared to design, furnish and erect the entire system. And from its complete line, recommend the right equipment for the job.

Link-Belt conveying and elevating equipment carries the coal from rail or dockside to storage areas and bunkers. Stackers and shovel-cranes stockpile and reclaim. Railroad car dumpers and shakers, screens, crushers and dryers perform other important functions.

And coal is just one of the basic materials conveyed and processed by Link-Belt equipment. In mine, mill or plant—wherever movement of materials is required—Link-Belt welcomes the opportunity to propose improved mechanization . . . help you reduce costs and increase output.

LINK-BELT COMPANY

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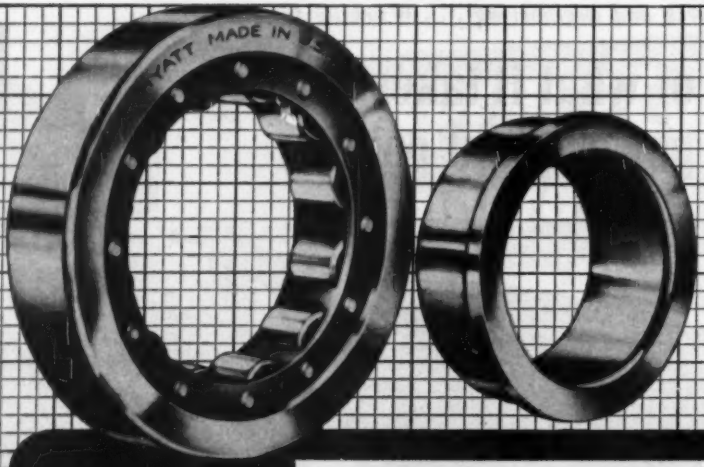
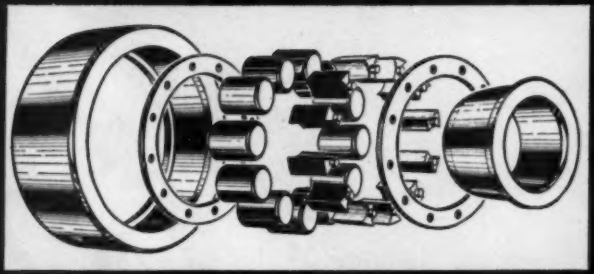


Locating.
High Capacity
Bearings...



HYATT HY-LOADS

THE R-WB type of Hyatt Hy-Load is a two-part roller bearing with a single flanged, separable inner race. Rollers are retained by a conforming bar cage and flanges at both ends of the outer race.

Painstaking attention to all construction details such as flange squareness on races, uniformity of roller diameters, lengths and end squareness, plus high surface finishes, results in quieter-operating, longer-lasting bearings. The construction of this bearing provides heavy load-carrying capacity; smooth, quiet performance and permits high-speed operation.

Flanged races on these bearings provide for endwise shaft location and accommodate light or intermittent thrust in one direction. When used in pairs they can locate shafts or carry light thrust in either direction.

* * *

Proper bearing application can improve the equipment you are designing or building. Be sure of your bearings. Consult your Hyatt Catalog or write for further information. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

FAIRBANKS-MORSE DIESELS CAN ELIMINATE YOUR

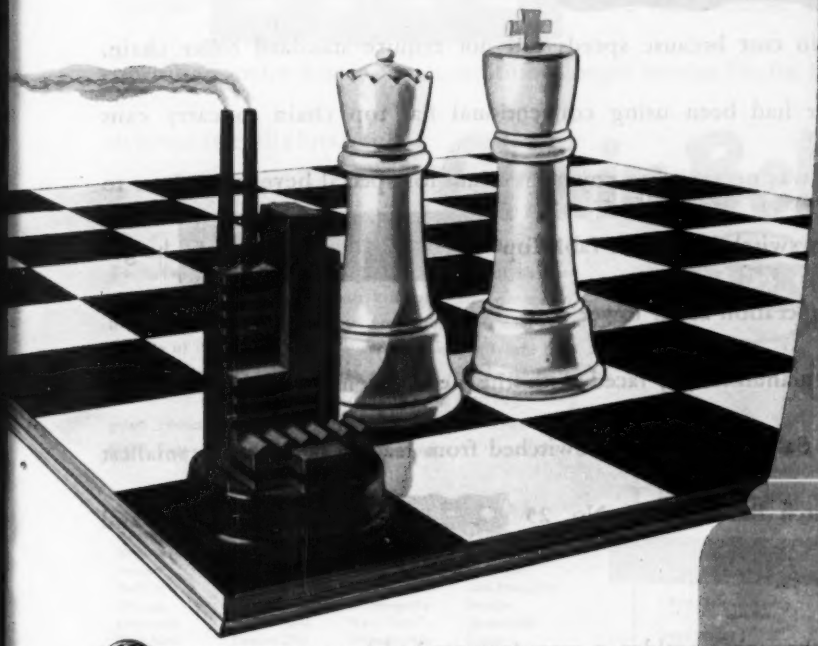
Power Checkmate

Poor power factor, adverse current characteristics, surge loads . . . any one of these conditions can put your plant in a power checkmate. You are then paying a penalty that can mean the difference between profit and loss.

What's the Next Move in Your Plant?

Look at your power problem. Then look at this representative list of advantages brought to you by Fairbanks-Morse Diesel power generation. These are *proved* answers to your problem . . . based on over 50 years' experience in industrial and municipal power generation.

If power has you in a checkmate, write us today, outlining your problem. Fairbanks-Morse Engineering can help decide your next move to put power costs and performance in order. Fairbanks, Morse & Co., Chicago 5, Ill.



Put Your Power Costs and Performance in Order

1 ***Handle Peak Demand*** . . . reduce peak demand values for lower purchased power rates.

2 ***Power Factor*** . . . in-plant power generator can eliminate power factor penalties.

3 ***Emergency Power*** . . . insurance against lost production and damage resulting from line failures.

4 ***Handle Surge Loads*** . . . that may now be affecting current characteristics of entire plant.

5 ***Plant Expansion*** . . . need not be restricted due to lack—or expense—of ample power.

6 ***Useful Heat*** . . . lube oil, water and exhaust heat can be turned from waste to profit.

7 ***Chemical Value*** . . . exhaust gases are high in free nitrogen—available for economical fixation of nitrates, ammonia, etc.

8 ***Insurance Advantage*** . . . of diesel over gasoline engine, for example, will soon pay for installation.

9 ***No Weather Worries*** . . . ice, snow, sleet, wind storms can't stop plant operations.

10 ***Handle Increasing Load*** . . . in-plant power economically adds to current capacity as loads increase.

11 ***Fuel Economy*** . . . use diesel oil, natural gas or sewage gas for added economy.

12 ***Remote Locations*** . . . distance from transmission lines needn't curtail plant expansion.

13 ***More Compact Power*** . . . Fairbanks-Morse engines give you more power per foot of floor space, more power on present foundation.

14 ***Minimum Attendance*** . . . Fairbanks-Morse in-plant generating sets require far less supervision or maintenance.

15 ***Save Cost*** . . . of running in new line where present transformers and power lines are already loaded.

FAIRBANKS-MORSE,

a name worth remembering

DIESEL AND DUAL FUEL ENGINES • DIESEL LOCOMOTIVES • ELECTRICAL MACHINERY • PUMPS • SCALES • RAIL CARS • MAGNETOS • FARM MACHINERY

Why take it for

We don't know the reason, but somehow chains seem to be taken for granted. If a chain for driving, timing or conveying has operated reasonably efficiently, that same chain is specified year after year. Yet, case after case shows that important savings can be made if these important functions are viewed with an eye for cost reduction and improved performance. For example:

● A manufacturer had been using a standard roller chain for years on his machine. A Rex Field Sales Engineer showed him that he could use a Baldwin-Rex Double Pitch Roller Chain and get the same operating efficiency at a substantial reduction in cost because speeds did not require standard roller chain.

● Another manufacturer had been using conventional flat top chain to carry cans through his machine. It was necessary to pay a premium for special bevel top plates to avoid tipping of cans. By switching to Rex TableTop® he got even smoother tip-free operation at far lower cost.

● A business machine manufacturer, faced with the need for more accurate timing, consulted his Rex Field Sales Engineer and switched from leather belts to the smallest roller chain—¼-inch pitch Baldwin-Rex No. 25 —and accomplished his objectives.

● In carrying material through a scalder, a manufacturer had been using conventional steel chain. By switching to Rex Cast Pintle Chain, he not only cut his costs but the chain lasted far longer.

granted?

● In another instance, a Rex Field Sales Engineer persuaded a manufacturer to switch from the pin-and-cotter roller chain he was using to a Baldwin-Rex Riveted Roller Chain. The change not only resulted in an initial cost saving but in longer life since the rivets have greater holding power.

● To a manufacturer of construction machinery, who had been using cast manganese steel chains, a Rex Field Sales Engineer recommended the use of Rex Steel Chabelco Chains. Since these chains are designed for efficient operation under dusty, dirty conditions, longer service life for both chains and sprockets at lower overall costs resulted.

Chain Belt COMPANY
OF MILWAUKEE

Because Rex Field Sales Engineers have all the resources of a complete chain line at their command, they can recommend without prejudice the exact type or size of chain that will deliver the most efficient performance at the lowest cost to you and your customers. You'll find it will pay you to consult with him regarding your chain application problems. Call or write your Field Sales Office, or mail the coupon.

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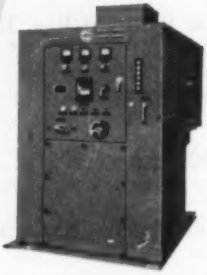
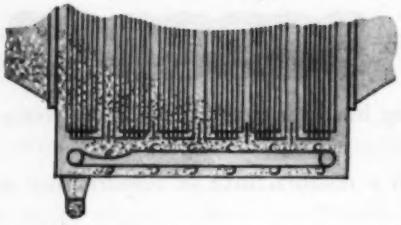
Let's be practical about precipitators

1



This Koppers "packaged" mechanical or vacuum tube power pack is not restricted to an area near the precipitator. It can easily be installed in any convenient place in the plant. Result: Compact designs! More flexibility!

2



This Koppers exclusive—the bottom drag scraper—provides continuous dust removal. Cumbersome hoppers are eliminated and dust handling is simplified. Result: Lower operating costs! Less space requirement!

Here are two ways Koppers engineers simplify precipitator operation for you!

PERFORMANCE GUARANTEED!

Koppers engineers protect your investment in an electrostatic precipitator by guaranteeing both the recovery or gas-cleaning *efficiency* and the *residual content* left in the gas after cleaning. Koppers-Elex electrostatic precipitators are designed, engineered, fabricated, erected and guaranteed *under one contract* by Koppers Company, Inc.

IN ADDITION to high efficiency, Koppers concentrates on the practical aspects of electrostatic precipitator design. Shown above are just two of the many practical features which simplify operation.

Besides these compact power packs and the continuous dust removal features, Koppers-Elex electrostatic precipitators may be of the multiple-chamber type. This means one chamber may be shut down for inspection or maintenance without stopping the gas-cleaning action. The dirty gas is simply diverted through other chambers where cleaning continues.

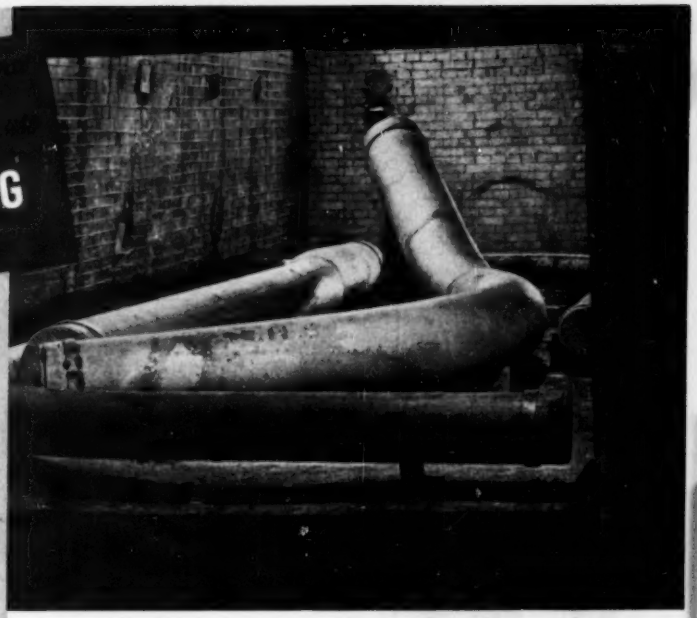
Because rapping is *sectionalized*, re-entrainment is minimized. And because successive collection fields can be separately *energized*, maximum voltage can be applied to each field—with higher gas-cleaning efficiency resulting. Pressure drops are negligible.

IF YOU HAVE A GAS-CLEANING PROBLEM, write and outline the details for us to review. There is no obligation. Just address your letter to: KOPPERS COMPANY, INC., *Precipitator Dept.*, 226 Scott Street, Baltimore 3, Maryland.

KOPPERS®

Koppers-Elex ELECTROSTATIC PRECIPITATORS

M. W. KELLOGG



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M KELLOGG W

What happens to power piping here is vitally important . . . *because*—

The necessity for heat treating high-temperature, high-pressure alloy power piping, after both bending and welding, is an accepted fact. But it is the *means employed* that determine the ultimate quality of the material.

Take *this* piping scheduled for one of the larger U. S. utility plants. It has been fabricated into sub-sections by experienced Kellogg benders and welders . . . men who have produced the critical piping for power stations putting out *more than six and a quarter million KW's.*

But all this skill *can* be wasted in the furnace during heat-treating, if specific procedures are not meticulously followed. In the first such treating step, ferritic piping is *normalized* or full-annealed to homogenize the grain structure, after it has been hot bent to the desired shapes.

Normalized piping must then be *tempered*—by reheating and subsequent cooling through a carefully controlled cycle. This eliminates undesirable hardness caused by the formation of martensite during the rapid cooling while normalizing.

When normalized and tempered piping has been welded, it must again enter the furnace for *stress relieving* of the weld areas. During this operation, any substantial variation from specified temperatures may produce differences in hardness between the weld areas and surrounding metal — greatly increasing the possibility of operating failures.

To assure that utility piping is free of such potential problems, Kellogg's Metallurgical Lab sets heat treating procedures for each assembly . . . and to guarantee adherence to those procedures Kellogg furnaces are extensively instrumented. Laboratory supervision of shop practices such as these is one of the *means* that guarantee quality when you specify Kellogg power piping.

OTHER FABRICATED PRODUCTS including:
Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Drums and Shells . . . Heat Exchangers . . . Process Piping . . . Bends and Headers . . . Forged and Welded Fittings . . . Radial Brick Chimneys

for 51 years an integral part of industrial progress!

The M. W. Kellogg Company (A Subsidiary of Pullman Incorporated)
New York, Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London and Paris.

Walworth manufactures a complete line of Gate, Globe, Angle, Check, and Lubricated Plug Valves, made of Stainless Steel, Steel, Iron, Bronze, and Special Alloys in a wide range of sizes and temperature-pressure ratings.

Fittings of steel, iron, and bronze are also manufactured in all conventional types and sizes.

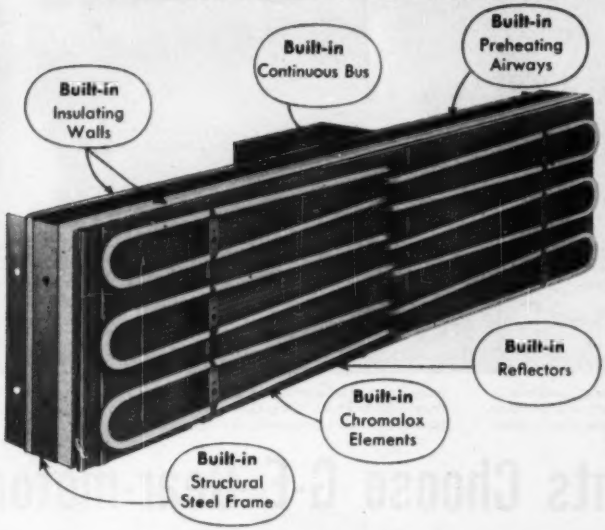
WALWORTH

valves and fittings

60 East 42nd Street, New York 17, N. Y.

Distributors in principal centers throughout the world

Announcing a **new** and **better** *INFRARED* Generator



CHROMALOX *Electric* RADIANT PANELS

Now, more efficient *far*-infrared comes in convenient pre-engineered panels, reducing oven building to a matter of determining heat requirements and assembling panels to fit the job.

CHROMALOX Electric Radiant Panels generate more uniformly absorbed *far*-infrared heat with quick heat-up and reduced oven lengths.

It's the *far*-infrared wave length that makes the difference.

- ✓ 9200 Btu's per square foot output per hour.
- ✓ Insulated for voltages to 575 V.
- ✓ Lowest installed cost per kilowatt and per square foot.
- ✓ Work temperatures to 700° F. easily obtained.
- ✓ Accurate "dialed" control.
- ✓ Absolutely uniform radiation—no hot or cold spots.
- ✓ Built to UL and NBFU requirements.

Now. . . Oven Building as Simple as A B C

It's easy to build ovens of any desired height and length with lightweight Chromalox Electric Radiant Panels. Panels come in 1 x 4 ft. and 2 x 4 ft. sizes, ready to erect and connect with easy-to-follow instructions in each carton. Chromalox on-the-spot engineering assistance to help determine your requirements is yours—no obligation, of course.

CHROMALOX *Electric Heat*

Does More – Better – Consistently

Radiant Heating Division EDWIN L. WIEGAND CO.,
7646 THOMAS BLVD., PITTSBURGH 8, PA.

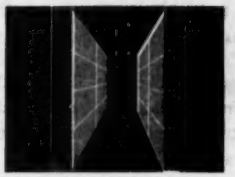
CHROMALOX FAR-INFRARED

For Baking, Drying, Curing, Dehydrating

and many other applications.

9 WAYS BETTER

1. **Longer wave length**—absorbed equally fast by all colors.
2. **Shatter-proof construction**—nothing to break and contaminate.
3. **Non-diminishing output** from all-metal Chromalox tubular heat generators.
4. **Uniform heat**—no hot or cold spots.
5. **High intensity radiation**—with more watts per square foot.
6. **Quick heat-up** with energy transformed instantly into heat on the work.
7. **Low-cost oven assembly.**
8. **Infinitely variable output**—from 0 to 100% of capacity.
9. **Additionally safe** for any work involving volatiles.



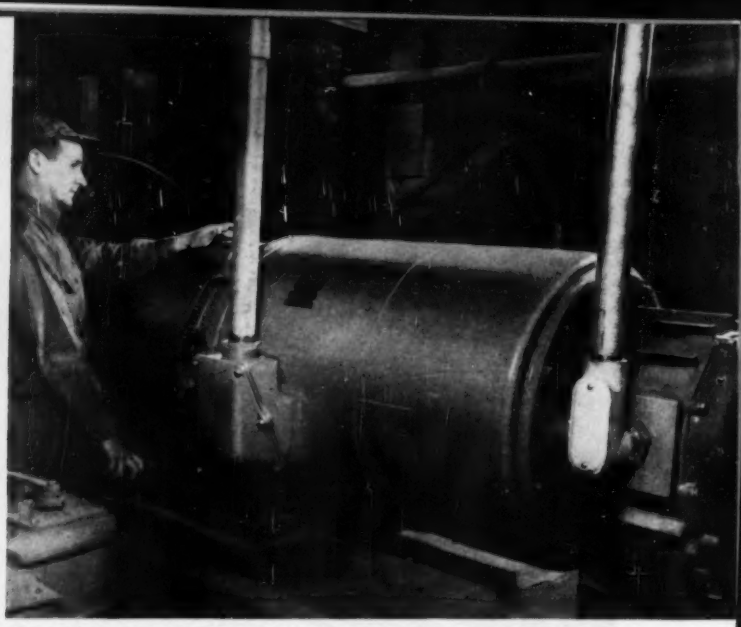
Easily erected banks of Chromalox Radiant Panels are ideal for line production. Far-infrared heat is radiated directly and uniformly without hot spots over entire work area.

Chromalox Radiant Panels can be erected into any oven shape. Rugged construction permits their use in assembly lines, even when hazards of splashed liquids, volatiles and moisture are present.

Get this Bulletin

It contains complete information, specifications and application ideas for the use of Chromalox Radiant Panels. Write for your copy today.

IC-66



F. W. Stock & Sons needed a better drive on grinding machines in flour mill. Picture at left shows old drive when shaft was powered by belts from motors and speed reducers that also drove other lines. Instead of another motor and speed reducer for new drive, they switched to a 75-hp G-E gear-motor (right) to gain additional power, modern equipment, savings on initial costs.

Three More Plants Choose G-E Gear-motors

One reports output up 20% at "A" mill; Others compactness, low maintenance

A large, independent flour mill and two prominent machinery builders have been added to the long list of industries profitably using General Electric Gear-motors.

F. W. Stock & Sons, report a production increase of 20% in their "A" mill since a 75-hp G-E Gear-motor was installed to drive flour grinding machines.

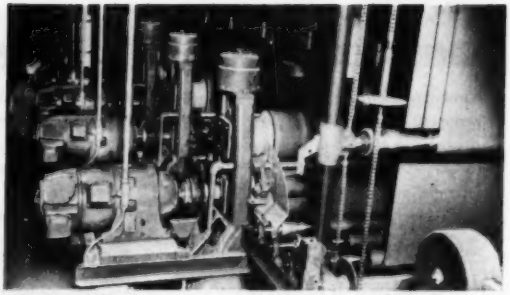
H. W. Butterworth & Sons, textile machinery manufacturer chooses G-E Gear-motors to drive machines requiring a reliable, compact low-speed drive.

F. X. Hooper Co., manufacturer of corrugated fibre box machinery, likes G-E Adjustable-speed Gear-motors because of their flexibility, trouble-free operation.

Throughout all industry, General Electric Gear-motors show "on the job" proof that they are best for most low-speed drives. And *prompt delivery* of Gear-motors is assured through warehouse stocks located in thirty-three key industrial areas. To solve your motor drive problems, contact your nearest G-E office or Distributor. *General Electric Co., Schenectady 5, N. Y.*

735-8

GENERAL ELECTRIC



Nine General Electric d-c gear-motors drive Butterworth soaper in Fruit of the Loom textile plant. G-E gear-motors also power agers, padders in this continuous-process finishing range.

G-E ACA adjustable-speed gear-motors now drive new F. X. Hooper partition slotters. The first installation of this modern equipment was made at a plant of the Owens-Illinois Glass Co. of California.

Spinning Realities
This formed copper tube (⅜" O.D.) is an excellent example of a long accurate reduction, ending in an opening with a controlled I.D. The metal at the end, you will note, is considerably thicker than the wall of the original tube.
By means of the Wolverine Spun End Process* it is now possible to produce an accumulator-dryer (as shown left) that will (1) keep moisture out of the refrigeration system, (2) eliminate separate dryer, thus reduce costs, and (3) obviate possibility of plug-up, thereby removing any chance of pressure drop.
The finest shell for a fire extinguisher, formerly made from straight wall tube requiring both ends to be capped, is now made in one piece by having both ends spun. Leaks in joints are eliminated and more dependable units result. The new method achieves higher production at lower costs.
This part was formed from a tube in two operations: (1) end was formed to a semi-spherical shape by spinning, followed by (2) a combined process of coining the end flat and piercing the holes in a punch press.
Here is a good example of "long neck" type of reduction. A tube 1⅛" O.D. has been reduced to ⅜" O.D. for a distance of 4⅛". The beginning wall thickness is .022" and the reduced portion is .045". This one-piece construction eliminated many difficulties presented in former method of manufacture.
*Patented process owned exclusively by Wolverine Tube Division of Calumet & Hecla Consolidated Copper Co.
Wolverine Tube and the Wolverine Spun End Process available in Canada through Wolverine Tube Co., London, Ont.
These are only a few of the hundreds of ways that the Wolverine Spun End Process has contributed immeasurably in increasing production output, saving on materials, reducing assembly costs, and with it all, attained more operating efficiency in the parts so produced.
WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Co.
INCORPORATED
Manufacturers of seamless, nonferrous tubing
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Want to help build an atomic submarine?...
Design an atomic power plant?

START YOUR

LIFETIME CAREER IN ATOMIC POWER

at

Westinghouse

Westinghouse Atomic Power Division has a new plant in the outskirts of Pittsburgh. Laboratories are completely new. Equipment is right up to the minute.

The tools are here to explore atomic energy as a great source of power for transportation and industry. Opportunities for original work are almost without limit.

Westinghouse is now searching for the men who can use these tools and opportunities . . . who want to build a *life career* around atomic power work . . . who want to get in while this great new industry is still on the ground floor.

Here you will work with your kind of people. Every fourth person in the Division is an engineer or scientist. More than half the top Westinghouse executives are engineers. As the exciting new potentials of atomic energy reveal themselves, we expect the men we employ now to provide the nucleus around which this new division will expand.

PROCESS DESIGN AND EVALUATION OPPORTUNITIES IN ATOMIC POWER ARE WAITING NOW FOR CHEMICAL ENGINEERS WITH 4 TO 10 YEARS OF THIS KIND OF EXPERIENCE . . .

DESIGN AND OPERATION of chemical process plants, power plants; design and application experience in plant control instrumentation, hydraulics systems, heat transfer, corrosion, ion exchange, thermal insulation, plant construction.

LIAISON with customers, contractors, designers of component equipment.

SUPERVISION of drafting work.

SALARIES—Open. Westinghouse Atomic Power Division wants good men, and will go out of its way to make attractive offers to good men, based on experience and ability.

LOCATION—Approximately 12 miles south of Pittsburgh. No traffic problems if you live in this general area. Many homes available and under construction. Good shopping in suburban area.

MANY EXTRAS—IN ADDITION TO GOOD PAY! INVESTIGATE!

- Help in finding suitable housing
- We pay interview expenses
- Low cost life, sickness and accident insurance with hospital and surgical benefits
- Modern pension plan
- Opportunity to acquire Westinghouse stock at favorable prices
- Privilege of buying Westinghouse Appliances at discount

HOW TO APPLY—These Westinghouse Atomic Power Division opportunities are not the kind that can be handled in a routine fashion. From the very beginning, you will be in communication with top executives of the Division. Address your application letter to

MR. C. LYNN, Manager of Engineering
Atomic Power Division
WESTINGHOUSE ELECTRIC CORPORATION
P.O. Box 1468
Pittsburgh 30, Pa.

What Mr. Lynn, and other executives who will scrutinize your application want to know is: Where and when you obtained your degree . . . how you did in school . . . where you have worked at your profession . . . what kind of work you have done.

In other words, right now we're more interested in your ability to fill current openings and to develop in the Westinghouse Atomic Power Division than we are in your vital statistics. Write your letter of application accordingly.

You will be in communication with men who are experienced in keeping secrets. All negotiations will be discreet, and *your reply will be kept strictly confidential. Write to Mr. Lynn today.*

→ **for sturdy reliability**

→ **low original cost**

→ **low operating cost**

LINE-O-POWER DRIVES

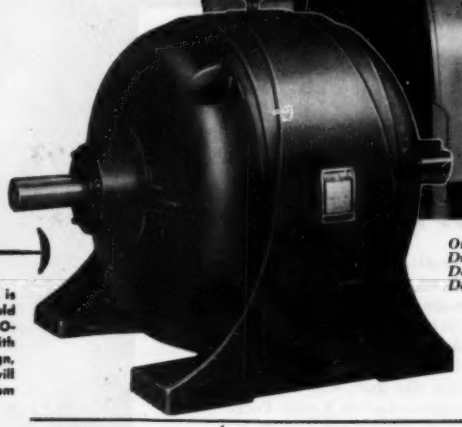
Here is one of a number of compact Foote Bros. Line-O-Power Drives installed in the Ford Motor Company Dearborn Specialty Foundry Rouge Plant. These drives are transmitting power to the bucket conveyors that raise sand to the hoppers.

Heavy loads, continuous service, dust conditions, all try the stamina of enclosed gear drives in applications such as this. Line-O-Power Drives have proved their ability to stand up, even under such tough conditions, and to assure long, trouble-free service.

FOOTE BROS. LINE-O-POWER DRIVES OFFER THESE FEATURES

Duti-Rated, high hardness gearing
Rugged cast iron housings
Modern streamlined design
Simplified construction
Direct splash lubrication
Efficiencies of 96% or higher
Capacities from 1 to 175 h.p.
Double or triple reductions
Ratios 5 to 1 up to 238 to 1

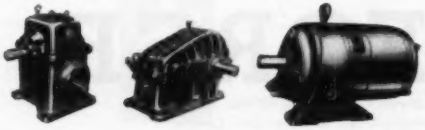
One of the many Foote Bros. Line-O-Power Drives installed in The Ford Motor Company Dearborn Specialty Foundry Rouge Plant, Detroit.



When one direction of rotation is desired and reverse direction would cause damage or danger, Line-O-Power Drives may be equipped with the Foote Backstop. Simple in design, rugged in construction, this unit will give years of service with minimum maintenance.

FOOTE BROS.

Better Power Transmission Through Better Gears



Foote Bros. Gear and Machine Corporation
Dept. Q, 4545 South Western Boulevard
Chicago 9, Illinois

Please send me a copy of Bulletin LPB on Foote Bros. Line-O-Power Drives.

Name .....

Company .....

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...have set their own standards

Many of the largest users of Welding fittings refuse to accept any other fittings than WeldELLS.

They have found that when the name, WeldELL, is stamped into a fitting, that fitting can be accepted without question for any service for which it is designed.

They have found that WeldELLS have features that please both the men who design and the men who erect welded piping . . . features that were pioneered by Taylor Forge . . . features that are combined in no other welding fittings.

They have found the answer to their every need in the greater range of sizes, weights and types of the WeldELL line . . . in the broader scope of materials.

Ask for up-to-the-minute facts about WeldELLS and Taylor Forged Steel Flanges.

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TAYLOR FORGE & PIPE WORKS, General Offices and Works: P.O. Box 485, Chicago 90, Ill.
Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

Now, say FLEXON

when you specify expansion joints for piping

Free-flexing units in stainless steel or copper for pressures to 30 psi; sizes to 48" I.D.
Controlled-flexing units in stainless steel or copper for pressures to 300 psi; sizes to 48" I.D.
Integral ring units in stainless steel for pressures to 5500 psi, temperatures to 1600° F; sizes to 6" I.D.

WITH the change of our corporate name from Chicago Metal Hose Corporation to FLEXONICS Corporation, CMH Expansion Joints are now known as FLEXON Expansion Joints. Just as the corporate name was changed to better describe the company's manufacturing activities, the name FLEXON should allow easier identification of these units.

Wherever motion is encountered in piping, the problem can be solved with FLEXON Expansion Joints. These dependable units are easily installed in new or existing lines and require only slightly more space than straight pipe. They cannot leak and require no maintenance.

Write for our new Expansion Joint "Design Guide". And remember, when you specify expansion joints, you now say, "FLEXON".

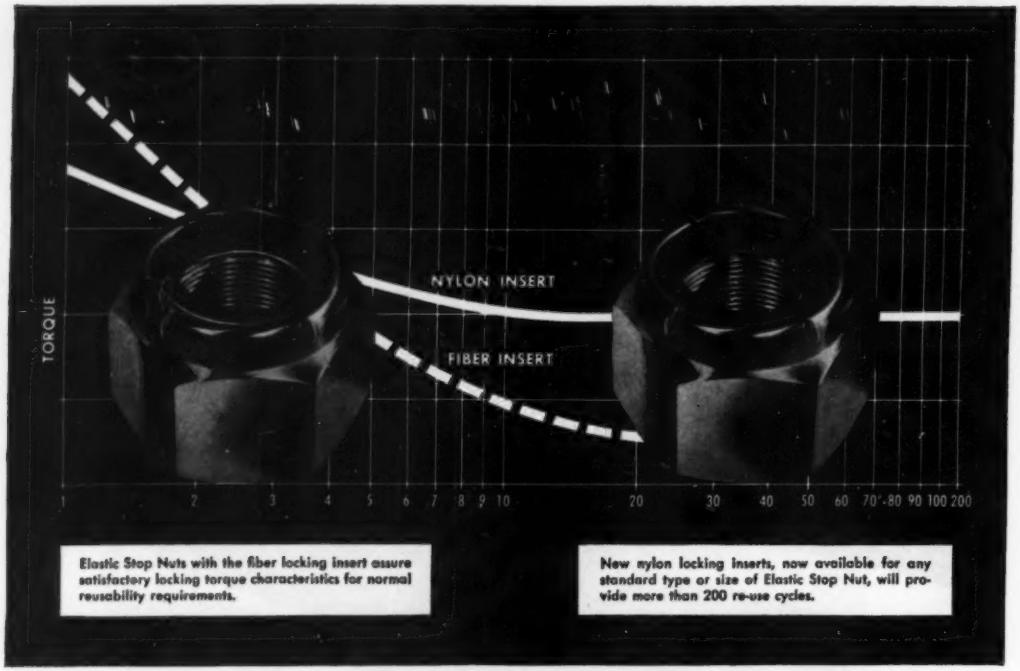
Flexonics *Corporation* **EXPANSION JOINT DIVISION**
1305 S. THIRD AVENUE · MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems • Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario



How do you measure Reusability?

UP TO FIFTEEN TIMES?

For assemblies that must be locked in place, Elastic Stop Nuts with fiber locking inserts guarantee a permanently secure grip—plus ample reusability to cover most normal maintenance requirements.

For assemblies that must be disassembled and reassembled five, eight, ten, or more times during normal use, fiber insert Elastic Stop Nuts make the ideal self-locking fastener.

When an Elastic Stop Nut is run on a bolt, the Red Elastic Collar hugs the bolt—actually makes a skin-tight fit against the entire contact length of the threads—and this controlled torque firmly resists vibration or shock. When the Elastic Stop Nut is removed from the bolt, the natural resiliency of the Red Elastic Collar is your guarantee of continuing torque when the nut is reapplied.

MORE THAN FIFTEEN TIMES?

Now, for assemblies that require constant adjustment or frequent disassembly for checking and maintenance, ESNA offers all standard types and sizes of Elastic Stop Nuts with the new nylon locking inserts.

Reusable up to 200 times with remarkably constant torque characteristics, these new Elastic Stop Nuts offer the one-piece construction, the shock resistance, and the moisture-seal features that many manufacturers now depend upon in the standard Elastic Stop Nuts.

One of these Elastic Stop Nuts is probably the solution to your most troublesome fastener problem. It will pay you to look into the self-locking performance of Elastic Stop Nuts. For information, write for a new, free booklet. **Elastic Stop Nut Corporation of America,** 2330 Vauxhall Road, Union, New Jersey, Dept. N5-611,

ESNA
TRADE MARK

ELASTIC STOP NUTS

NYLON AND FIBER INSERT TYPES ARE QUALIFIED TO SPEC. AN-N-5

PIPING THAT MOVES

. . . calls for supports that are flexible

Thermal deflection of piping in the high temperature piping systems of today's oil refineries requires supports that are flexible.

Where reactive forces at terminal points in a piping system must be kept within specified limits, constant-support type hangers are recommended. They are designed to provide substantially uniform supporting force equal to the pipe load throughout the travel range and should be used on high temperature and other critical lines.

When pipe lines are subject to vertical movement and restrictive conditions do not require the use of a constant-support type, variable spring hangers are recommended. They should be designed to support not less than 85% or more than 120% of the designed load for the total travel.

When necessary to prevent abnormal movement or vibration in pipe lines, controls or sway braces of the energy-absorbing or instant-acting, counter force type are recommended.

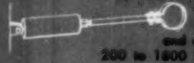
Grinnell manufactures a complete line of engineered pipe hangers and supports; maintains a laboratory staff of trained technicians; provides highly skilled assistance and advice right from the design stage; and offers experienced field engineering service.

Grinnell Pre-Engineered Variable Spring Hangers installed in one of the largest catalytic cracking plants.

Grinnell Constant Support on piping operated at temperatures up to 1100°F.

GRINNELL MODEL L CONSTANT SUPPORTS—maintain full safety factor in high temperature, high pressure systems. 3 physical structures accommodate maximum travel requirements of 2½, 5 and 10 inches; 16 sizes additionally cover numerous load ranges between 141 and 99,530 pounds.

GRINNELL PRE-ENGINEERED SPRING HANGERS—maximum variation in supporting force per ½" of deflection is 10½% of rated capacity—in all sizes. 16 sizes available from stock—load range from 74 lbs. to 9000 lbs.



GRINNELL VIBRATION CONTROL AND SWAY-BRACES—dampen vibration, oppose pipe sway and absorb shock. 3 sizes give full deflection forces from 200 to 1800 lbs.; have initial precompressed spring forces from 80 to 450 lbs. respectively.

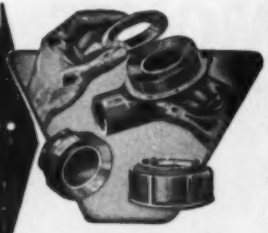
GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence 1, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

SIMPLICITY of DESIGN...



For Moving Pipe Lines

FLEXO JOINTS

For safe, unrestricted flow, Flexo Joints offer the strength of pipe *plus* the flexibility of hose — to convey fluids through movable pipe lines or to equipment while in motion. Just four simple parts, completely enclosed—no springs—no small or loose parts . . . long wear—low maintenance. Four styles—standard pipe sizes ¼" to 3".

Write for complete information.

FLEXO SUPPLY CO., Inc.

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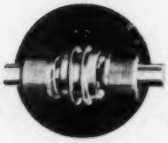
In Canada: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 13, Ont.

This Large Machine Has a



Marshmallow-Light Touch

The Peters Marshmallow Depositor performs numerous light-touch, high-speed operations for the baking industry. It's hopper deposits marshmallow or jelly on base cakes, which are fed continuously. ROCKFORD Pullmore CLUTCHES control the power transmission. Let ROCKFORD clutch engineers help design power transmission control for *your* "light-touch" machines.

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Eighteenth Avenue, Rockford, Illinois, U. S. A.

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B-W PRODUCTION MAKES IT AVAILABLE
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SAFETY CODE FOR INDUSTRIAL POWER TRUCKS

This Code covers the construction and design features of the driver-ride and driver-lead industrial power trucks, accident prevention guards and guarding devices, and use of mechanized equipment in hazardous locations. It provides general safety regulations for trucks and it supplies 35 safety rules for truck operators.

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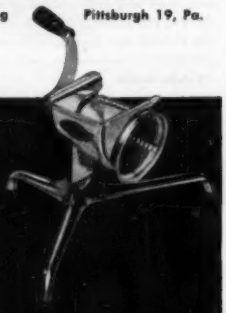

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ON ALL 5 COUNTS

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LONG LIFE • CLEANNESS
SAFETY

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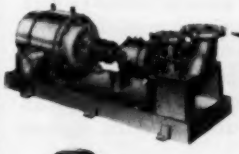

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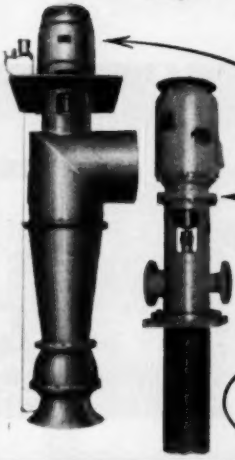

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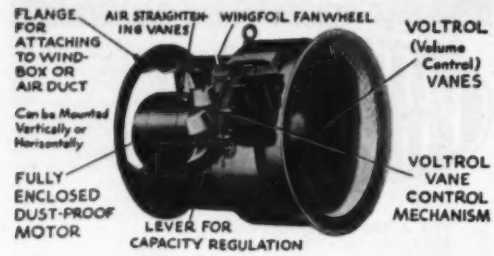
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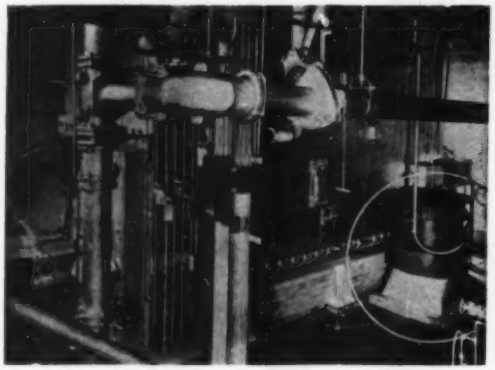

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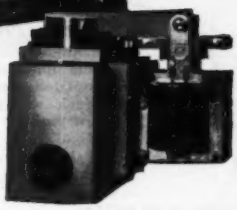

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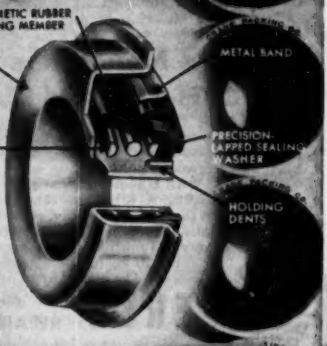

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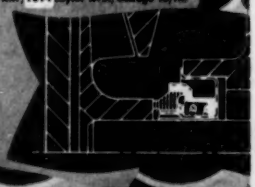

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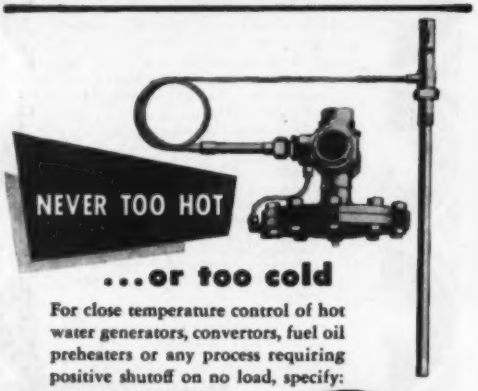

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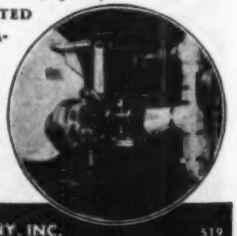

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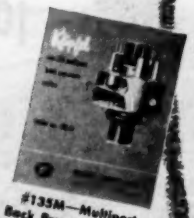

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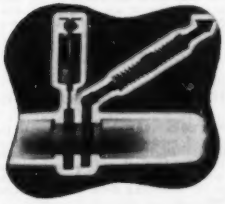

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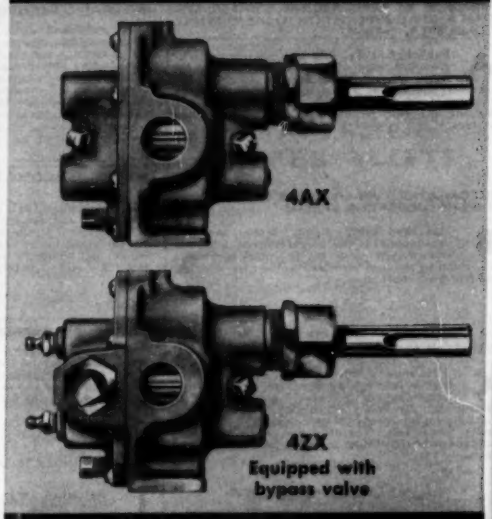
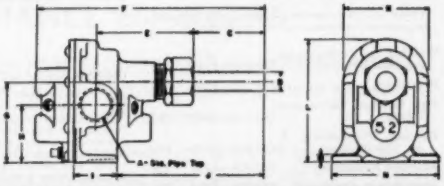


CAPACITY TABLES

Gallons per minute @ 1,725 R.P.M. — lbs. sq. in.

Pump No.	2 lbs.	20 lbs.	40 lbs.	60 lbs.	80 lbs.	100 lbs.
No. 1½	2.10	1.92	1.75	1.63	1.55	1.50
No. 2	4.10	3.75	3.58	3.42	3.25	3.17
No. 3	7.42	7.08	6.75	6.50	6.33	6.17
No. 4	10.67	10.17	9.67	9.17	8.83	8.50
No. 7	19.75	19.33	19.00	18.67	18.33	18.08
No. 9	23.33	22.92	22.50	22.08	21.67	21.33



DIMENSION TABLE – SERIES 52 PUMPS

Pump No.	A	B	C Min.	E Max.	F	G	H	I	J	K	L	M	N	O
1½	1/8	3/8	2 1/16	2 21/32	6 1/16	1 7/16	1 13/32	1 1/16	4 1/16	1 13/16	2 27/32	9/16	2 1/4	1 7/16
2	1/8	1/2	1 7/16	2 31/32	6 9/16	2 23/64	1 23/32	1 9/32	4 1/32	2 3/8	3 9/16	1/2	2 3/8	1 13/16
3	3/8	5/8	2 1/8	3 1/32	7 1/16	2 5/8	1 7/8	1 9/32	4 17/32	2 3/4	4	1/2	2 1/2	1 11/16
4	1/2	5/8	2 1/4	3 1/4	7 7/16	2 5/8	1 7/8	1 13/32	4 25/32	2 3/4	4	1/2	2 1/2	1 1/2
7	3/4	5/8	2 1/4	3 9/16	7 7/16	2 9/16	2 9/16	1 13/32	4 25/32	2 3/8	5 1/4	5/16	4	2 9/16
9	1	5/8	2 1/4	3 9/16	7 13/16	2 9/16	2 9/16	1 21/32	4 25/32	2 3/8	5 1/4	5/16	4	2 9/16

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Pump No.	No. 1½	No. 2	No. 3	No. 4	No. 7	No. 9
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K B1.1—1949 (Third Edition, Published 1951). $3.00. Gives basic dimensions of coarse thread series for sizes from 1/4 inch to 4 inches and fine thread series from 1/4 to 1 3/4 inch diameters in the unified screw threads; the 8-, 12-, and 16- thread series of the 1935 Standard with an extra fine series added; six tolerance classes; formulas from which values in the tables are determined; and other useful supplementary information.

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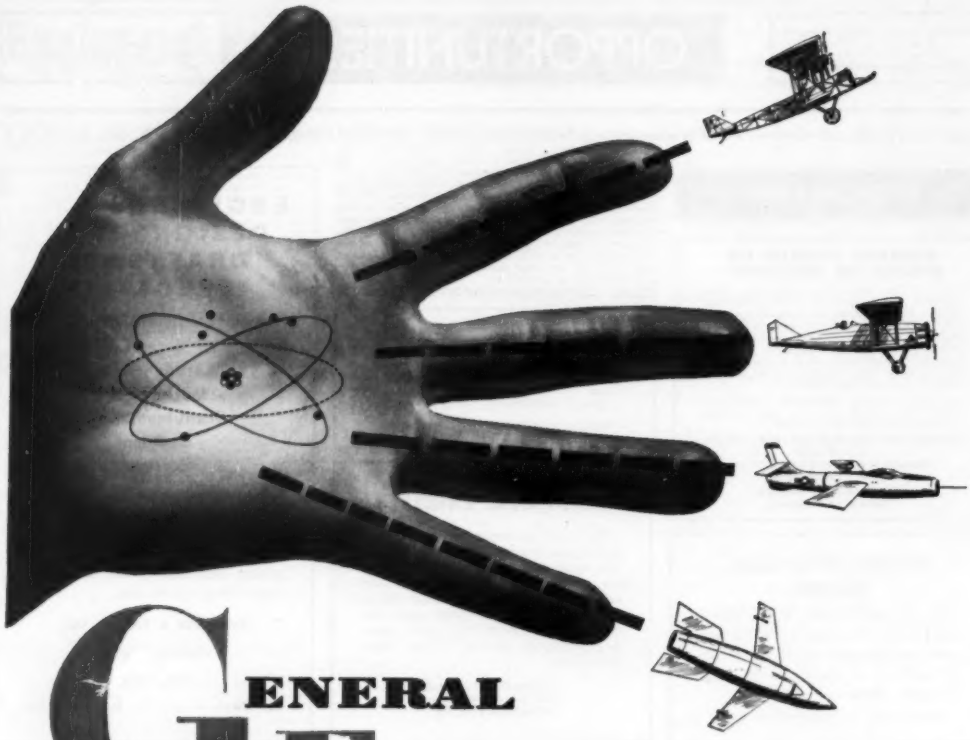

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PHILLIPS PETROLEUM COMPANY

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"OPPORTUNITIES" Section This Month 139-147

POSITIONS OPEN

Continued from Page 145

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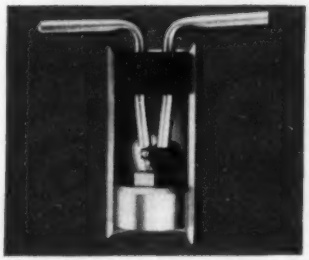
THE TRANSISTOR

A picture report of progress



FIRST TRANSISTORS were of this point contact type (picture three times life size). Current is amplified as it flows between wires through a wafer of germanium metal. These transistors are now being made at the Allentown plant of Western Electric, manufacturing unit of the Bell System. They will be used in a new selector which finds the best routes for calls in Long Distance dialing.

NEW JUNCTION TRANSISTORS, still experimental, also use germanium but have no point contacts. Current is amplified as it flows through germanium "sandwich" —an electron-poor layer of the metal between two electron-rich ends. This new transistor runs on as little as *one-millionth* of the power of small vacuum tubes.

MUCH HAD TO BE LEARNED, especially about the surface of germanium and the effect of one part in a million of alloying materials. Transistors promise many uses—as amplifiers, oscillators, modulators . . . for Local and Long Distance switching . . . to count electrical pulses.

ASSEMBLY PROBLEMS, such as fixing hair-thin wires to barely visible germanium wafers, have been solved through new tools and mechanized techniques. Finished transistors withstand great vibration and shock. Engineers see many opportunities for these rugged devices in national defense.

MOIST PAPER AND COIN generate enough current to drive audio oscillator using junction transistors. Half as big as a penny matchbox, an experimental two-stage transistor amplifier does the work of miniature-tube amplifiers ten times larger.

A tiny amplifying device first announced by Bell Telephone Laboratories in 1948 is about to appear as a versatile element in telephony.

Each step in the work on the transistor . . . from original theory to initial production technique . . . has been carried on within the Laboratories. Thus, Bell scientists demonstrate again how their skills in many fields, from theoretical physics to production engineering, help improve telephone service.

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Improving telephone service for America provides careers for creative men in scientific and technical fields.

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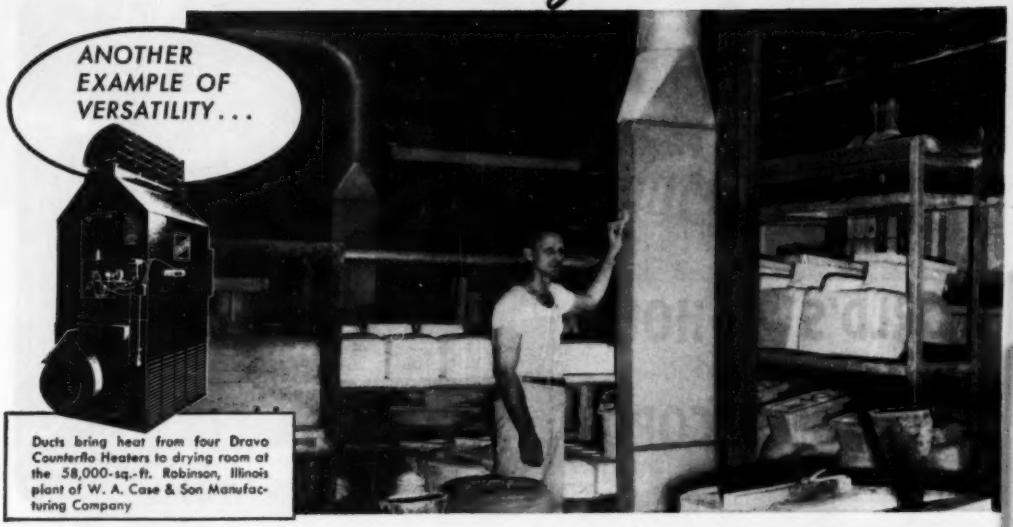

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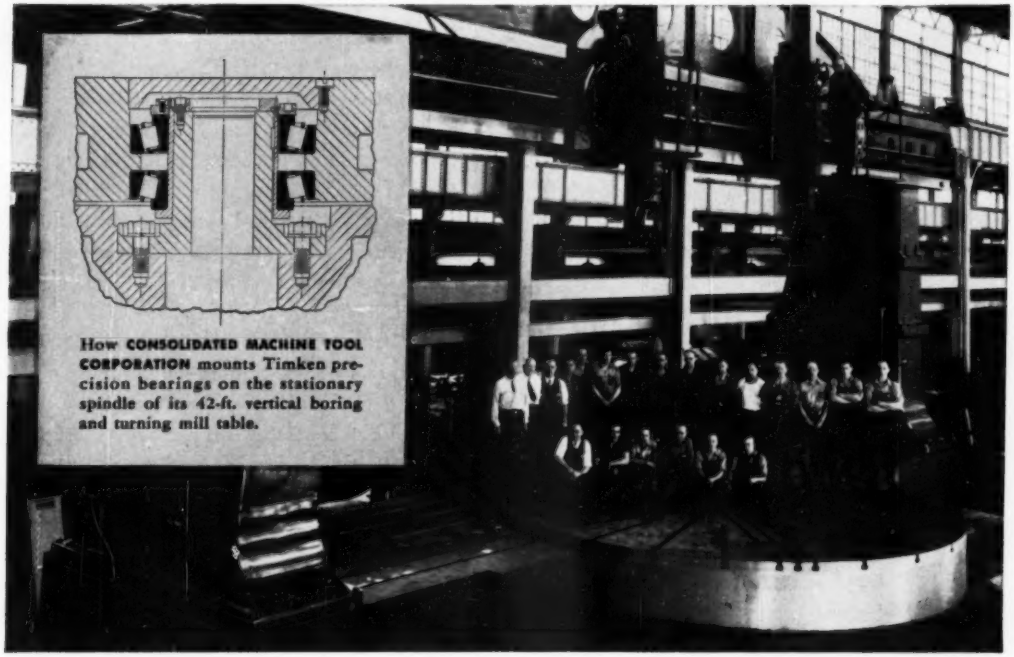

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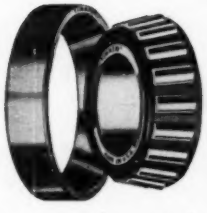

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